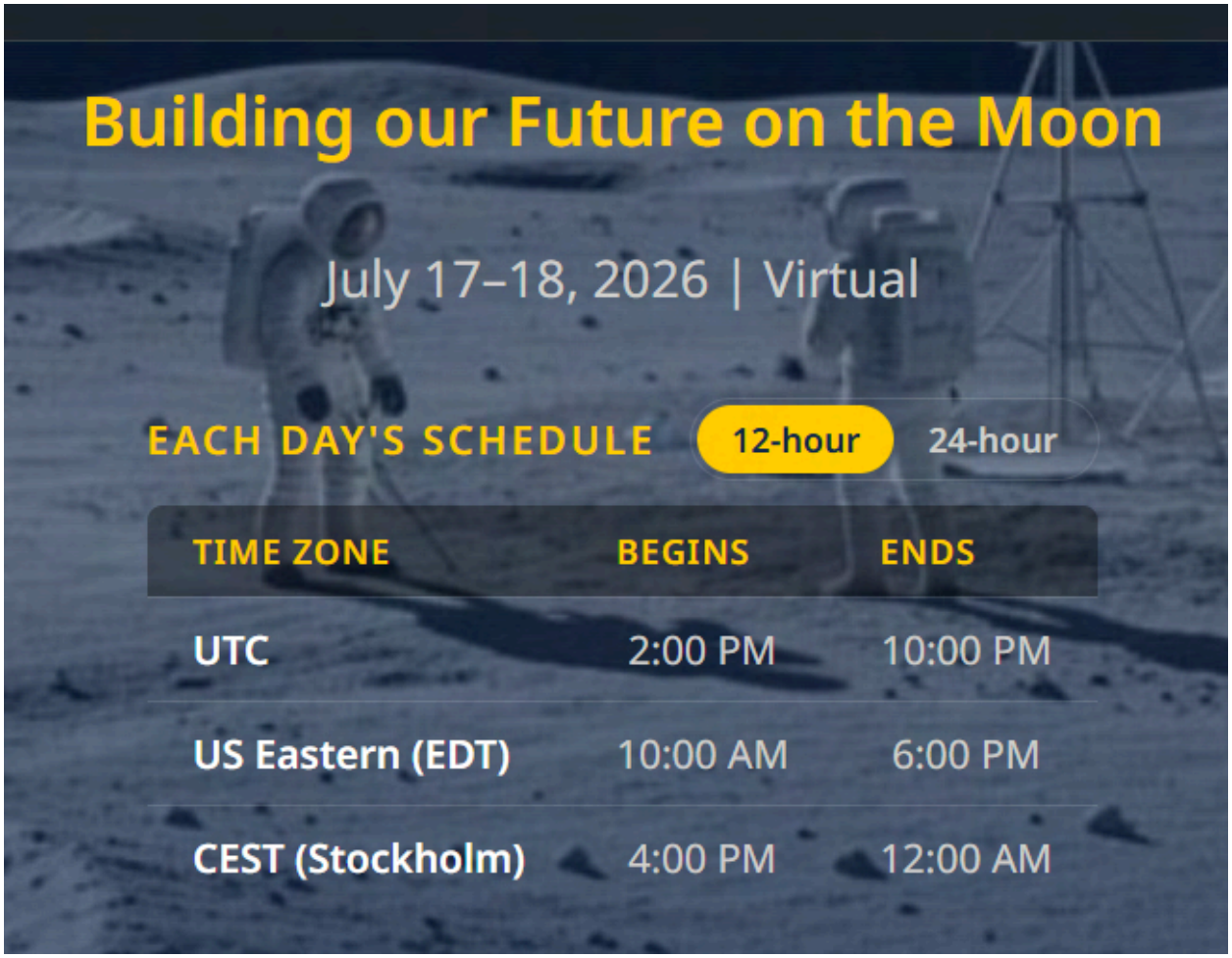
LUNAR DEVELOPMENT CONFERENCE 2026

BOOK OF ABSTRACTS

The Moon Society | July 17-18, 2026 | Virtual Edition

Compiled and Curated by Veronica Chiaravalli



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https://www.worldtimebuddy.com/


DAY 1
FRIDAY 17TH OF JULY

DAY 1 - FRIDAY 17TH OF JULY

		Day 1		
Slot	**Time**	**Presenter**	**Affiliation**	**Presentation Title**
1	04:00 - 04:30 PM CEST	Veronica Chiaravalli	The Moon Society / Emerging Technologies Sweden	Engaging the Frontier: A Framework for Multi-Agent Social Robotics and Adaptive HRI in Off-World Settlements and Mega-Habitats
	04:30 - 04:40 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
2	04:40 - 05:10 PM CEST (to be confirmed: either this slot of the one afterwards)	Dr. Anna Xygkou-Tsiamoulou and Max Medina	School of Computing, University of Kent, UK	Human-Centred by Design: Embedding Human Factors and Ergonomics into Lunar Habitat Architecture
	05:10 - 05:20 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
3	05:20 - 05:50 PM CEST	Doug Plata (last minute changes)	The Space Development Network	The Case for the Moon
	05:50 - 06:00 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
4	06:00 - 06:30 PM CEST	Alastair Storm Browne	Storm Browne Enterprises LLC	From Lunar Bases to Lunar Cities -

				The Evolution of Settling the Moon
	06:30 - 06:40 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
5	06:40 - 07:10 PM CEST	Colin Lennox	EcoIslands LLC	Self-Organizing Wetland Bioreactors (SOWBs) Application to Mining Reclamation: Direct and Indirect Bioremediation as a Design Tool for Mine Influenced Water (MIW) Benefaction
	07:10 - 07:20 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
6	07:20 -07:50 PM CEST	David Schrunk	Science of Laws Institute	Science Directed Lawmaking for Lunar Governance
	07:50 - 08:00 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
7	08:00 - 08:30 PM CEST	James R. Wertz, Claudio Olany, John Collins, Issac Koerner	Microcosm/USC	Social Lunar Settlements: Having Fun, Making Lots of Money, and Living Longer (?) on the Moon

	08:30 - 08:40 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
8	08:40 - 09:10 PM CEST	Fernando Gomez & Victor Tenorio	*MineSense Technologie and University of Arizona*	Sensing Intelligence for Lunar Mining: Real-Time Material Characterization in Autonomous Excavation and Conveyor Systems at the South Pole
	09:10 - 09:20 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
9	09:20 - 09:50 PM CEST	Victor Tenorio, Marc dos Santos. Last minute change: Muhammad Waqas will not be presenting: Tenorio will present his part.	University of Arizona	Production Strategy for Icy Regolith Resource Utilization Using a Modular Conveyor Network in the Lunar South Pole Region
	09:50 - 10:00 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
10	10:00-10:30 PM CEST	Nasir Rizwan	SAFAR (South Asian Facility for Analog Research)	High-Altitude Analog Research for Lunar Surface Preparation: Site Selection, EVA Protocol Validation, Human Performance, and Astrobiology

				Reconnaissance at 4,700m ASL
	10:30 - 10:40 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
11	10:40 - 11:10 PM CEST	Nevin Shah	The Spring Institute for Forests on the Moon	From Regolith to Living Soil: Building the Future Lunar Workforce through the Spring Institute's Global Citizen Science Pipeline
	11:10 - 11:20 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
12	11:20-11:50 PM CEST	Dr. Claire Nelson		Beyond Analog Missions: A Frugal Framework for Developing ATLASS—A Persistent Virtual Living Testbed for Global Lunar Analog Research
	11:50 - 12:00 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
13	12:00-12:30 AM CEST	James Plaxco	Chicago Society for Space Studies	The Top Ten Challenges to the Economic Development of the Moon
	12:30 - 12:40 AM CEST	10-Minute Buffer / Introduction & Tech Transition		

14	12:40 - 01:10 AM CEST	Wanjiku Chebet Kanjumba	Vicillion	From Orbit to Outpost: Human-AI Coordination for Lunar South Pole Logistics
	01:10 - 01-20 AM CEST	10-Minute Buffer / Introduction & Tech Transition		
15	01:20 - 01:50 AM CEST	Abigail Watson	Orbital Health Systems, Inc	Moonbase 2026: Building a Lunar Colony Simulator with Healthcare-Grade Infrastructure
	01:50 - 02:00 AM CEST	10-Minute Buffer / Introduction & Tech Transition		
16	02:00 - 02:30 AM CEST	Nadav Shaltiel	Nova school of law - The Space Law Research Centre (SPARC)	Transplanting Jurisprudence, Not Law: Why Space Governance Requires a Foundational Rethinking of Legal Theory
		END OF DAY 1		


DAY 2
SATURDAY 18TH OF JULY

DAY 2 - SATURDAY, 18TH OF JULY

		Day 2		
Slot	**Time**	**Presenter**	**Affiliation**	**Presentation Title**
1	04:00 - 04:30 PM CEST	James Burk	The Moon Society	From Advocacy to Action: The Moon Society's Role in the NASA Moon Base
	04:30 - 04:40 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
2	04:40 - 05:10 PM CEST	Alan Meyer		Project Shackleton
	05:10 - 05:20 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
3	05:20 - 05:50 PM CEST	Lars R. "Jones" Vadjina	Future Dreams GmbH	The Invisible Infrastructure: Why AI May Become the Operating System of Lunar Civilization
	05:50 - 06:00 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
4	06:00 - 06:30 PM CEST	Ethan Williams and Victor Tenorio	School of Mining Engineering and Mineral Resources - University of Arizona	San Xavier Decline as an Analog Lava Tube for Testing Autonomous Lunar Mining Systems and Infrastructure
	06:30 - 06:40 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
5	06:40 - 07:10 PM CEST	Cameron Smith	Portland State University	Diversification of Lunar Surface Space Suits

	07:10 - 07:20 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
6	07:20 - 07:50 PM CEST	Nicolas Nelson	Luna City Press	Good Fences Make Good Neighbors
	07:50 - 08:00 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
7	08:00 - 08:30 PM CEST	Holger Isenberg	Areo Info LLC	Returning Galileo to his original location on the Moon
	8:30 - 08:40 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
8	8:40-9:10 PM CEST	Dr. Silvia Schmalzl	Dr. Schmalzl Consulting	The Living Wall: Pioneer Organisms as Biological Infrastructure in Lunar Lava Tube Habitats
	09:10 - 09:20 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
9	09:20 - 09:50 PM CEST	Quinn Morley	Unleashed Robotics	Tetherless Drilling Robots (Borebots) for Polar Lunar Prospecting
	09:50 - 10:00 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
10	10:00-10:30 PM CEST	Hal Fulton	Open Space Foundation	Beyond Earth: Toward a Pattern Language for Lunar Settlements
	10:30 - 10:40 PM CEST	10-Minute Buffer / Introduction & Tech Transition		
11	10:40 - 11:10 PM CEST	Francesca Mison	Moliri Space Energy	Moliri's Case for In-Situ Construction and Repair Capability in the Lunar Economy
	11:10 - 11:20 PM CEST	10-Minute Buffer / Introduction & Tech Transition		

12	11:20-11:50 PM CEST	Daniel Tompkins	MoonDrops	MoonDrops, A whole Moon approach
	11:50 PM - 12:00 AM CEST	10-Minute Buffer / Introduction & Tech Transition		
13	12:00 - 12:30 AM CEST	Nona Zakoyan + Piercarlo Galeazzo	Thales Alenia Space	Argonaut: Advancing Sustainable Lunar Exploration
	12:30 - 12:40 AM CEST	10-Minute Buffer / Introduction & Tech Transition		
14	12:40 - 01:10 AM CEST	Michael Helton	Helton Associates	Asteroid Impact Protection - Long Term Solution
	01:10-01:20 AM CEST	10-Minute Buffer / Introduction & Tech Transition		
15	01:20-01:50 AM CEST	Madhu Thangavelu	Astronautical Engineering Department, Viterbi School of Engineering & School of Architecture Faculty, International Space University	Commercial CisLunar Orbital Amateur Astronaut Space Tourism
		END OF DAY 2		

LDC 2026: Book of Abstracts Introductory Address

Veronica Chiaravalli - Moon Society
(veronica@moonsociety.org)

The Moon Society — Securing the Eighth Continent

The Moon is no longer a distant destination of historical memory; it has officially re-entered the sphere of active human presence.

With the historic triumph of NASA's crewed Artemis II mission in April 2026, humans have successfully returned to cislunar space for the first time in over fifty years. Backed by a rapidly scaling fleet of international and commercial robotic landers, we are actively mapping the polar peaks, drilling for volatile ice, and deploying the initial surface technologies that will support permanent habitats. The era of lunar settlement has shifted from a theoretical roadmap into a physical, operational reality.

As a 26-year-old international organization focused solely on our celestial neighbor, The Moon Society is uniquely positioned to guide, inspire, and coordinate this rapid transition. However, our ultimate success depends on human momentum.

To bridge the gap between temporary exploration and permanent cislunar civilization, The Moon Society needs YOU.

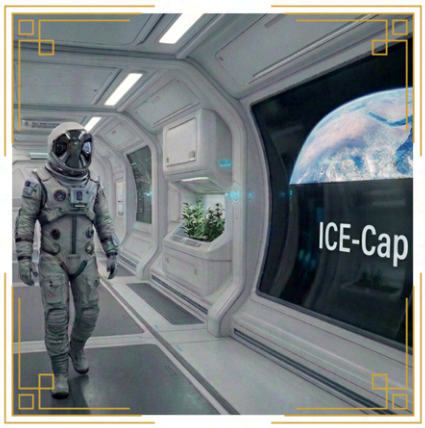
We need our members to step forward as architects, redefining our organizational mission for this new space age. We need visionary leaders to spearhead active projects, and disciplined "doers" to ensure their execution. We need trilingual, multi-disciplinary

ambassadors to communicate the raw potential of lunar development and ignite global interest in what our multiplanetary future could be.

If you want to see a thriving, self-sustaining society on the Moon, then you are called to help build it. The frontier is open—let us make it a reality together.


DAY 1
FRIDAY 17TH OF JULY

Engaging the Frontier: A Framework for Multi-Agent Social Robotics and Adaptive HRI in Off-World Settlements and Mega-Habitats



Title: Engaging the Frontier: A Framework for Multi-Agent Social Robotics and Adaptive HRI in Off-World Settlements and Mega-Habitats

Author: Veronica Chiaravalli
Affiliation: Founder, CEO, & CRO, Emerging Technologies Sweden | VP, The Moon Society
Track: Human-Robot Interaction (HRI), Space Habitats, & Orbital Leadership
E-mail: vc.multiplanetaryx@gmail.com
Website: exponentialtechs.com

Bio

Veronica Chiaravalli is the Founder, CEO, and Chief Robotics Officer (CRO) at Emerging Technologies Sweden, and the Vice President of The Moon Society. Serving as the HRI Framework Lead for the Orbital Leadership Program, she specializes in space psychology, architectural blueprints, and HRI democratization to support human teams navigating the civilizational shift of living and working alongside autonomous systems in commercial orbital infrastructures, mega-habitats, and off-world settlements.

As a strategic innovator, Veronica conceptualized and launched the MultiplanetaryX Innovation Hub, an immersive 3D aerospace workspace built on the Virtway platform. Her deep domain expertise in crew training and space psychology—honed through the School of Disruption—informed her engineering of ICE-CAP, a proprietary generative AI crew support dashboard designed to mitigate cognitive fatigue and optimize operational micro-interventions for pioneers and crews in isolated, extreme environments.
A featured presenter at the Space Renaissance International 4th World Conference 2026, Veronica actively shapes the global discourse on automated systems and the overarching orbital command frameworks required as civilian infrastructure expands to include space hotels and elevators. Her human-centric approach to off-world isolation is further backed by her intensive analog astronaut training program at Habitat Marte. Previously awarded an Honorary Mention at the Innovation Awards for strategic crisis frameworks via Copenhagen Business School, she synthesizes adaptive methodologies at exponentialtechs.com to ensure civilian pioneers remain securely in control of our next civilizational frontier.

Abstract

As humanity undergoes a fundamental civilizational shift toward long-term off-world settlement, civilian pioneers, settlers, and space tourists will permanently live and work alongside highly autonomous robotic systems on the Moon, Mars, and across an increasingly active Low Earth Orbit (LEO) populated by space hotels, space elevators, and commercial infrastructure. This multi-layered expansion demands a radical evolution in

operational command. While current aerospace paradigms focus heavily on mechanical automation, they overlook a critical systemic vulnerability: the intense communication barriers between remote teams and the severe cognitive load induced by the "Intelligence Inversion"—a state where autonomous operational speeds accelerate exponentially beyond human textual absorption limits. For civilian settlers managing complex environmental infrastructure, staring at dense telemetry logs introduces severe fatigue, leading to tracking latency and isolation-driven communication friction.

To address these challenges, this paper introduces a novel framework focused on the democratization of Human-Robot Interaction (HRI) for remote teams, commercial operators, and orbital leadership programs. The architecture transitions command environments away from exclusive, high-perplexity data interfaces into universally accessible, intuitive systems. By filtering high-velocity data down to essential variance metrics, the system translates complex operational data into natural language structures paired with expressive metadata. These streams are dynamically routed to embodied social robotic interfaces acting as conversational partners. By translating data variance into natural human expressions, gaze tracking, and vocal inflections, the framework bridges the speed gap of the intelligence inversion. The result is a democratized HRI system that lowers cognitive friction, preserves crucial team communication networks, and provides orbital leaders and commercial space pioneers with a scalable blueprint to maintain human agency, business growth, and secure orbital command oversight in our next civilizational frontier.

Human-Centred by Design: Embedding Human Factors and Ergonomics into Lunar Habitat Architecture

Title: Human-Centred by Design: Embedding Human Factors and Ergonomics into Lunar Habitat Architecture
Track: Track Alpha: Surface Infrastructure & ISRU
Author: Dr. Anna Xygkou-Tsiamoulou
Affiliation: School of Computing, University of Kent, UK
Co-Presenter: Max Medina
Affiliation: LAVA (Laboratory for Visionary Architecture) Architects
E-mail: A.Xygkou-Tsiamoulou@kent.ac.uk
E-mail: Arq.maxmedina@gmail.com

Bio
Dr. Anna Xygkou-Tsiamoulou is a Titans Space Astronaut Candidate and Director of Space Environmental and Behavioral Systems at Titans Space Industries, specializing in Human Factors and Human Behavior and Performance by implementing immersive technologies and conversational AI for astronauts' mental health and cognitive training. She holds a PhD in Computing from the University of Kent, UK, where her research pioneered the use of Virtual Reality and conversational AI to support companionship and social connectedness for groups vulnerable to isolation. At Titans Space Industries, she leads interdisciplinary research designing AI-driven behavioral support systems, biophilic modular habitats, and closed-loop health monitoring to help astronauts thrive psychologically, socially, and cognitively in confinement. Her mission is to cultivate human adaptability and wellbeing beyond Earth, with a particular commitment to inclusive spaceflight that makes exploration more sustainable for diverse and "other-able" crews.

Bio
Max Medina is a Honduran architect, entrepreneur, and architectural explorer focused on designing the future of cities on Earth and beyond. He is a Director at LAVA Architects where he develops visionary projects that merge architecture, technology, sustainability, and storytelling.

Max's work ranges from iconic mixed use developments and masterplans to research on lunar habitats and space architecture. He is an Astronaut Candidate with Titans Space Industries, exploring how the lessons learned from designing for space can improve life on Earth.

His projects and ideas have been presented internationally through universities, conferences, and industry events, winning awards, always driven by a simple belief: architecture should inspire people, solve real problems, and help shape a better future.

Through design, research, and public speaking, Max aims to push the boundaries of what architecture can become, creating places that people remember and experiences that connect humanity with the next frontier.

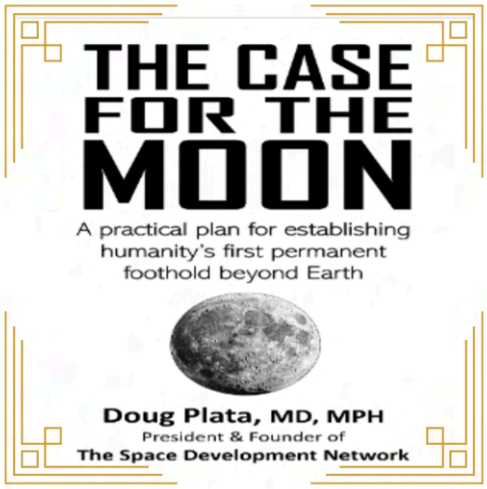
Abstract

As lunar missions shift from short missions toward permanent settlement, the dominant risk migrates from launch and landing to the sustained problem of living on the Moon. Yet lunar habitats are still largely conceived as engineering envelopes; shielded, pressurised containers sized to survive radiation, thermal extremes, micrometeoroids and the near-vacuum exosphere, with the crew accommodated only after the shell is fixed. This talk argues that on the Moon survivability and habitability are distinct problems, and that human factors and ergonomics (HF/E) must operate as a co-design discipline from the first architectural move rather than as a late compliance review.

Using the Voyager City modular settlement at Malapert Massif as a worked case study, this talk applies a design-stage human-systems integration method that reads each lunar constraint as a human requirement and resolves it in form. The method runs along two axes: our architectural scales (settlement, module, section, envelope) and five cross-cutting layers (reduced-gravity ergonomics, ICE behavioural health, workload, human-robot teaming, and Safety-II resilience), with requirements aligned to established habitability standards.

Applied to a "living-system" architecture of cellular modules and a two-level crater strategy, the analysis makes latent human-centred intent explicit: the growth network becomes a privacy and social gradient; the surface-plus-subsurface section becomes vertical zoning by exposure tolerance; the robotic service loop becomes a function-allocation problem minimising crew EVA; and the functional programme is re-read zone-by-zone as answers to human needs. The design team's thesis, "every constraint becomes form," is recast as "every constraint becomes a human requirement." The result is a repeatable, standards-aligned framework that treats habitability as an auditable objective early enough to shape mass, layout and construction, making crew performance, health and wellbeing the measure of habitat success.

The Case for the Moon



Title: The Case for the Moon
Track: Alpha: Surface Infrastructure & ISRU
Author: Doug Plata, MD
Affiliation: President & Founder, The Space Development Network
Email: dougspace007@gmail.com
Website: http://DevelopSpace.info/moonbook, 909-557-7483

Bio

Doug Plata is a physician in Redlands, CA. He is the President and Founder of the Space Development Network, a free-to-join organization of space advocates networked to advance space development projects. Doug has served on multiple committees of different space advocacy organizations. He has made dozens of appearances and presentations at conferences and the radio. He recently oversaw the completion of a full-scale Moon-Mars base mock-up named the InstaBase which is to be displayed during major Starship launches. His primary interest is the establishment of large, inflatable, and sustainable bases as the initial permanent bases on both the Moon and Mars. The Space Development Network's website is at: DevelopSpace.info.

Abstract

Given current developments, it appears likely that SpaceX will have a fleet of fully reusable, super heavy lift vehicles in the 2030s. What can be done with this capability on the Moon?

Dr. Plata has recently completed a book titled, The Case for the Moon. In it he describes an Initial Permanent Crew in a Starship on the lunar surface that has been horizontalized using tethers. These eight people would demonstrate to the world humanity's first permanent foothold beyond Earth.

Meanwhile, cargo landings would deliver very large inflatable habitats making up an International Lunar Base. In a coordinated manner, countries would fund their companies to provide competing goods and services for the large and rapidly growing base all the while exploring the Moon on behalf of their citizens.

Constructed and tested on Earth before launch and easily inflated on robotically prepared ground, very large habitats could be set up without the limitations, time, energy, and safety concerns of other habitats such as 3D printed ones.

The inflatable habs would each specialize in one particular function. Connected together with a network of transport tunnels, the base would grow up to city size while prices of goods and services dropped to the point which private settlers could afford. As one

language group became large enough, they would likely have their own separate colonies established resulting in the growth of the lunar population and the beginnings of politically independent entities.

From Lunar Bases to Lunar Cities - The Evolution of Settling the Moon

Title: From Lunar Bases to Lunar Cities - The Evolution of Settling the Moon
Author: Alastair Browne,
Affiliation: Storm Browne Enterprises LLC
E-mail: alastair11@gmail.com, **Website**:stormbrowneenterprisesllc.org

Bio

Alastair S Browne is a writer and lives in Durham, North Carolina. He is the author of Cosmic Careers, a book on future jobs in the coming space movement, and Building the Space Infrastructure, his latest book, which is about developing space from Low Earth Orbit to the Lunar surface, both published internationally. His other writings include topics pertaining to different problems this world is facing today and how they can be resolved for the benefit of all.
Alastair attended North Carolina State University in Raleigh, and earned a B.S. degree in Statistics, and the University of North Dakota, in Grand Forks, where he obtained an M.S. degree in Space Studies.

Abstract

Planning a lunar base has to be done step by step, starting from the very beginning when we land on the lunar surface and build a habitat.Long term survival will require all the means needed to survive on Earth, and this includes food production and mineral, water, and oxygen extraction. If we are determined to meet these challenges, we can end up creating an independent and self-supporting city, complete with industry, food sources, and a self contained atmosphere, all leading to a thriving economy.
Products from mining the Moon's resources can be manufactured from factories located on the lunar surface to expand the lunar settlement into a city. From there, more cities, farms, and industries can be built.Afterwards, both raw and manufactured materials can be exported to other space colonies elsewhere in space, and on Earth.Because of the Moon's location, its resources, its low gravity, vacuum,and extreme temperature, new advances in science and technology would also be made. This is especially true in new energy sources, medical advances, computers, transportation, and life sciences. As industry progresses, we must be able to build more complicated devices, meaning life support systems, propulsion systems, even space vehicles. We will also be able to advance in the medical field in ways we cannot imagine at the present moment.Developing the Moon will be challenging but the benefits will far outweigh the costs.The Moon is our first stepping stone to the infinite void of space, and it has almost everything to offer humanity to meet this challenge and take our first steps.

Self-Organizing Wetland Bioreactors (SOWBs) Application to Mining Reclamation: Direct and Indirect Bioremediation as a Design Tool for Mine Influenced Water (MIW) Benefaction

Title: Self-Organizing Wetland Bioreactors (SOWBs) Application to Mining Reclamation: Direct and Indirect Bioremediation as a Design Tool for Mine Influenced Water (MIW) Benefaction
Track: Alpha: Surface Infrastructure & ISRU
Author: Colin Lennox**, Reference**: 2026-06-11T00-40-30-204Z-a81946
Affiliation: EcoIslands LLC
Email: colin@ecoislandsllc.com

Bio

Colin A. Lennox is a scientist and entrepreneur who started EcoIslands LLC in 2009 as a floating wetland research and implementation company. The floating wetland technology morphed into the self organizing wetland bioreactor (sowb) technology in 2011 when EcoIslands was asked what they could do for mining reclamation. Drawing on experience in agriculture, mining, wastewater, and methane production, all of the relevant remediation needs combined to adapt sowbs to biological life support systems (blss) for the moon, Mars, and terrestrial humanitarian applications.

Abstract

Self-organizing wetland bioreactors (SOWBS) provide a designer of mine influenced water (MIW) treatment systems with a tool to harness ubiquitous microbiological processes in methodical and novel layouts for a variety of MIW load reclamation and beneficiation. SOWBs efficacy comes from the ability to grow and maintain very high masses of attached biofilms that are self selecting dependent on the MIW load entering any portion of a SOWB treatment system. As the MIW load is sequestered or remediated, the net water biochemistry changes, developing new and ever changing selective pressures on the predominant, but ever shifting, biofilm metabolisms found throughout the treatment train. Depending on the MIW's load, influences such as iron, aluminum and manganese are either directly or indirectly remediated by the self organized biofilms. Direct bioremediation (DBR) is when a microbe uses the influence in its metabolic triplet to respire, grow and reproduce. Indirect bioremediation, or IBR, are processes such as biofilms "stickiness" and the tendency to colonize and coat all surfaces in the SOWB, including precipitating matter, that leads to capture and sequestration in the SOWB of influences that are not part of a metabolic triplet. This paper provides designers with a rudimentary framework to apply self organization by elucidating mine influence specific DBR and IBR. This knowledge can be applied to other waste streams beyond mining. The experiences herein are not learned through classical experimental design using controls and variables, but on iterative trial and error, so this study is, by definition, long and involved.

Science Directed Lawmaking for Lunar Governance

Title: Science Directed Lawmaking for Lunar Governance
Track: Track Beta: Subsurface Settlement
Author: David Schrunk, 2026-06-10T15-10-51-236Z-c8b66f
Affiliation: Science of Laws Institute
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Bio

David G. Schrunk is an aerospace engineer and medical doctor with board certifications in the medical specialties of nuclear medicine and diagnostic radiology. He has authored numerous papers and presentations on scientific and law topics related to the exploration and development of the Moon and is a co-author of the book, "The Moon: Resources, Future Development, and Settlement," published by Wiley-Praxis in 1999; a second edition was released in 2007 by Springer-Praxis.

Abstract

Laws of government are implements, like computers and life support systems, that are essential for the success of human activities in space. When the first Moon settlement is established, a new “lunar” government will be required to create a rule of law that secures the rights and liberty of the people (the “purpose of democracy”), oversees responsible lunar resource utilization, and facilitates the continued advancement of humankind on the space frontier. The problem is that traditional lawmaking (“TM”), as currently practiced by Earth governments, has virtually no quality standards and is unable to satisfy the purpose of democracy. Specifically, the TM is not a knowledge-based process, and it observes no standards for the responsible creation, evaluation, audit, and improvement of laws. The result is that it is unable to create laws that solve or mitigate societal problems. In response to recalcitrant problems, the TM produces more inadequate and defective laws so that the bodies of laws increase in size, cost, and complexity while serious societal problems, e.g. poverty, abuse of human rights, and burgeoning government debt, remain unsolved. To avoid the inconsistencies, costs, and failures of traditional lawmaking, a scientific system of lawmaking for space governance is proposed. Science-directed lawmaking, based on systems engineering, can be readily adapted for the creation, validation and maintenance of a rule of law that successfully and efficaciously satisfies the purpose of democratic government. This discussion reviews the flaws and omissions of traditional lawmaking and outlines the operation of science-directed lawmaking that will enable the future lunar government to satisfy the purpose of democracy and serve as a model for the success of future space governments.

Social Lunar Settlements: Having Fun, Making Lots of Money, and Living Longer (?) on the Moon

Traditional lunar settlement (left) vs. a social lunar settlement (right). Note the windowless and confined living quarters in the lower right of the traditional view.

Title: Social Lunar Settlements: Having Fun, Making Lots of Money, and Living Longer (?) on the Moon
Track: Alpha: Surface Infrastructure & ISRU
Reference: 2026-06-08T22-42-30-108Z-b8ad82
Author: James R. Wertz, Claudio Olany, John Collins, Issac Koerner
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Bio

Dr. James Wertz. Dr. Wertz is the President of Microcosm, Chairman of the Board of Scorpius Space Launch Co., and an Adjunct Prof. of Astronautics at USC. He is the editor and principal author of 7 technical astronautics books, including Reducing Space Mission Cost (RSMC), Space Mission Analysis and Design (SMAD – 3 editions), and the SMAD follow-on Space Mission Engineering (SME). The SMAD/SME books have been the most widely used technical references in astronautics for over 30 years. He has taught SMAD courses worldwide and is currently teaching a USC graduate course in a "Near-Term, Low-Cost, Commercial Lunar Settlement."

Abstract

People are expected to return to the Moon by 2030, but substantial lunar settlements are expected to still be several decades away, more than 80 years after Apollo. These traditional settlements are focused primarily on science, exploration, and possibly mining. In contrast, this work summarizes the potential for developing a near-term (i.e., starting now), low-cost, high-income, commercial and international social lunar settlement. By "social," we mean that the settlement maintains the science and exploration objectives but adds "social" activities, such as lunar tourism and burial, sports and entertainment, both formal education and educating the public, and co-branding and marketing. Additionally, social lunar settlements are populated primarily by ordinary people, not extensively trained astronauts or selenauts. Also, most of the work is inside, which dramatically reduces cost.Traditional science and exploration-oriented work on the Moon is of interest to a few hundred thousand people who are interested in astronomy, geology, and astronautics. In contrast, social programs are of interest to 8.2 billion people in over 200 countries and speaking 150 different languages – all of whom know about the Moon. Imagine yourself or your kids or grandkids riding around on a brand of bicycle that was currently being used on the Moon. Or imagine the Portuguese ambassador to the Moon talking from the Moon to a classroom in Portugal showing them the neat things you can do in 1/6 th g and telling them

in Portuguese (not in Spanish or French or English) that it is important for Portuguese speaking people to be a part of the expansion into the solar system. It is this broad commercial and international appeal that's largely responsible for dramatically increasing income, estimated at over $100B/yr after 10 years. It's the 1/6 th g that creates lots of fun and, maybe, the opportunity to live longer.

Sensing Intelligence for Lunar Mining: Real-Time Material Characterization in Autonomous Excavation and Conveyor Systems at the South Pole

Title: Sensing Intelligence for Lunar Mining: Real-Time Material Characterization in Autonomous Excavation and Conveyor Systems at the South Pole

Authors: ***Fernando Gomez***, *MineSense Technologies and* **Victor Tenorio**, *University of Arizona, vtenorio@arizona.edu*
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Bio

Victor Tenorio is Professor of Practice at the School of Mining Engineering and Mineral Resources, University of Arizona. His research interest is focused on Smart Mining and Decision Support Systems for optimizing productivity. Worked on several engineering projects in Peru, Chile, and the United States. Founder of Wildcat Moon Miners (2021), a research team dedicated to participating in Space Mining-related projects and competitions.

Bio

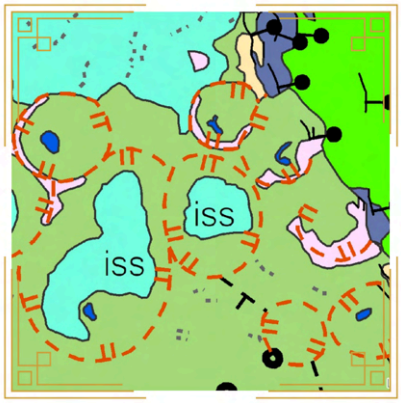
Fernando Gomez is a mining engineer and alumnus of the University of Arizona. He began his career in mining technology at Hexagon Mining, where he supported global clients in unlocking value across the mining value chain, from mine design to operational optimization. He is currently at MineSense Technologies, where he focuses on deploying innovative technologies to maximize ore recovery and improve downstream processing efficiency.

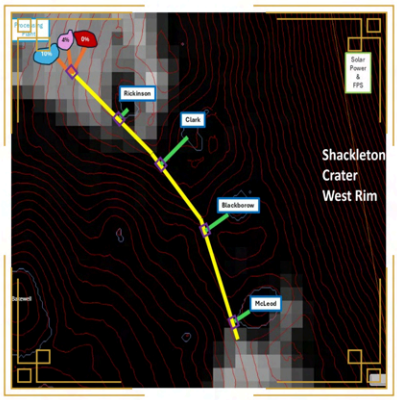
Abstract

Advanced sensing technologies are poised to transform lunar mining operations at the South Pole, where autonomous and teleoperated excavation systems must contend with permanently shadowed terrain under extreme cold, in icy regolith, and with significant communication latency. This work examines the application of multi-sensor payload-comprising high-frequency electromagnetic sensors, permittivity probes, near-infrared spectrometers, and force/torque systems integrated into NASA's Infrastructure Pilot Excavator (IPEX), shovel dippers, haul units, and conveyor networks for real-time characterization of icy regolith during extraction and transport.
Unlike terrestrial mining, a lunar ISRU system operates under strict energy, volume, and throughput constraints where processing material below ice-content thresholds wastes irreplaceable battery capacity and shortens mission life. By applying bulk ore-sorting principles at the extraction point, per-payload grade data enables IPEX to make immediate accept-or-reject routing decisions before haulage energy is spent. The value of real-time sensing compounds when integrated with equipment telemetry across the downstream process. Correlating grade data with excavator load cycles, haul unit energy consumption, conveyor throughput, and ISRU plant feed levels allow the system to dynamically adjust dig

sequencing, haulage scheduling, and plant feed rates. This enables predictive responses for routing low-ice payloads to secondary stockpiles, prioritizing high-grade zones when battery reserves are low, and preventing ISRU plant starvation or overflow. Transforming the operation from a fixed-sequence process into an adaptive, energy-aware production system. For Earth-based supervisory teams managing communication latency, onboard telemetry provides a high-fidelity operational picture that supports informed intervention without real-time control.

Production Strategy for Icy Regolith Resource Utilization Using a Modular Conveyor Network in the Lunar South Pole Region





Geomorphology and Contour Map of the Designated Area of Study (LROC/ACT)

Title: Production Strategy for Icy Regolith Resource Utilization Using a Modular Conveyor Network in the Lunar South Pole Region
Track:
Authors: Victor Tenorio, Marc dos Santos, and Muhammad Waqas
Affiliation: University of Arizona
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Bio

Victor Tenorio is a Professor of Practice at the School of Mining Engineering and Mineral Resources, University of Arizona. His research focuses on Smart Mining and Decision Support Systems for optimizing productivity. Worked on several engineering projects in Peru, Chile, and the United States. Founder of the -Wildcat Moon Miners (2021), a student research team participating in Space Mining-related projects and competitions.

Bio

Marc dos Santos holds a B.S. in Aerospace Engineering with a focus on Information Technology from MIT. He became a partner at Dos Santos International in 2004, having been integral to the company since its founding in 1997, where he organized the computer and communication systems. He has developed and optimized numerous processes and analytical tools, contributing significantly to the DSI Sandwich Belt High Angle Conveyors, overseeing projects from Australia to the Arctic Circle.

Bio

Muhammad Waqas is an Associate Professor of Practice at the School of Mining Engineering and Mineral Resources, University of Arizona. His research focuses on critical minerals, discrete element modeling, AI-based mining systems, and geomechanics. His teaching portfolio includes Surface Mine Planning and Design, Mining Equipment Operations, and Rock Excavation.

Abstract

Sustained human presence under NASA's Artemis program requires reliable access to in-situ resources, particularly water ice within permanently shadowed regions at the lunar South Pole. This conceptual presentation outlines an integrated excavation and material-handling architecture for extracting and transporting icy regolith from a chain of craters along the right side of the Shackleton–de Gerlache Ridge to processing infrastructure on the sunlit western rim of Shackleton Crater, building on prior ISRU Pilot Excavator and sandwich conveyor concepts. Low-reaction excavation at the crater floor transfers material to enclosed, inclined conveyor segments designed to traverse steep terrain while limiting spillage and dust mobilization. A modular conveyor network enables robotic deployment, incremental expansion, scalable throughput, and operational

redundancy. Power generation, thermal control, communications, and transfer stations are located within sunlit zones to enhance availability. Key challenges include extreme thermal gradients, abrasive regolith, deployment logistics, and autonomous operations. These are mitigated through robust mechanical design, fault tolerance, and a hybrid supervisory framework combining remote monitoring with autonomous control. The proposed architecture supports sustained icy regolith production for ISRU applications, including water extraction for surface operations, life support, and propellant production.

High-Altitude Analog Research for Lunar Surface Preparation: Site Selection, EVA Protocol Validation, Human Performance, and Astrobiology Reconnaissance at 4,700m ASL

Title: High-Altitude Analog Research for Lunar Surface Preparation: Site Selection, EVA Protocol Validation, Human Performance, and Astrobiology Reconnaissance at 4,700m ASL
Track: Track Alpha: Surface Infrastructure & ISRU
Author: Nasir Rizwan
Affiliation: SAFAR (South Asian Facility for Analog Research)
E-mail: iamnasirrizwan@gmail.com

Bio

Nasir Rizwan works at the intersection of space exploration, education, and emerging space ecosystems. Over the past five years, he has worked to shift Pakistan's space sector from awareness into real capability building, leading the country's largest space outreach initiative reaching over 20,000 students across underprivileged communities. That work earned him the Space Outreach Award at ICAST 2025 and recognition in Pakistan's 30 Under 30.

Deeply embedded in the global analog research community, Nasir has spent several years working closely with The Mars Society and contributing to analog mission operations. That experience became the foundation for SAFAR (South Asian Facility for Analog Research), Pakistan's first dedicated analog research initiative, currently developing a high-altitude analog station designed to bring together researchers, scientists, and engineers from across South Asia and beyond.

At its core, SAFAR is built on a belief that space is one of the most powerful fields for bringing nations together. and that the next chapter of human exploration belongs to everyone willing to help build it.

Abstract

Preparing human crews for sustained lunar surface operations demands research environments that combine genuine physiological stress, EVA operational complexity, and planetary science fieldwork under conditions that mid-latitude analog stations cannot produce. SAFAR (South Asian Facility for Analog Research), Pakistan's first dedicated analog research initiative operating under a formal MoU with The Mars Society, is conducting a pilot mission at Khunjerab in Northern Pakistan (4,700m ASL, Q3/Q4 2026) to generate transferable data relevant to Artemis-era lunar surface operations.

A core objective of the pilot is systematic site selection and field reconnaissance. The Khunjerab region contains high-altitude saline lakes hosting extremophile communities relevant to chemically extreme aqueous habitability research, permafrost formations analogous to confirmed subsurface ice dynamics on both Mars and the lunar poles, and glacial terrain offering access to preserved geochemical records. Crew traverses will follow structured documentation protocols to assess terrain accessibility, scientific instrumentation placement potential, and long-term facility siting feasibility, producing a

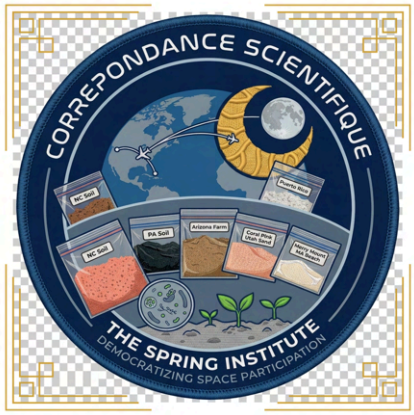
field-validated site characterization dataset to inform permanent analog infrastructure development.

At 4,700m, atmospheric pressure is approximately 55-60% of sea-level values. This hypoxic environment produces measurable physiological stress analogous to the cognitive and cardiovascular load anticipated during extended lunar EVA rotations, providing a controlled setting for studying crew decision-making under load, fatigue accumulation, circadian disruption, and operational error rates without orbital infrastructure.

The pilot targets a 10-14 day window with a multidisciplinary crew spanning human factors, EVA operations, and field science. The reduced ambient pressure at altitude additionally provides a meaningful test environment for pressurized suit and habitat systems, where the differential between internal and external pressure constitutes an engineering load absent from sea-level and mid-altitude analog stations.

This presentation will share site selection methodology, field reconnaissance findings, and research design rationale from SAFAR's approach to establishing high-altitude analog infrastructure as a credible, accessible complement to existing global analog programs.

From Regolith to Living Soil: Building the Future Lunar Workforce through the Spring Institute's Global Citizen Science Pipeline



Title: From Regolith to Living Soil: Building the Future Lunar Workforce through the Spring Institute's Global Citizen Science Pipeline

Author: Nevin Shah
Track: Track Alpha: Surface Infrastructure & ISRU
Affiliation: The Spring Institute for Forests on the Moon
E-mail: nevin@thespringinstitute.com

Bio

Nevin N. Shah is an interdisciplinary educator, biomedical scientist, and aerospace program leader dedicated to preparing the future workforce for the challenges of permanent space settlement. He serves as the North American Outreach Lead for the Spring Institute for Forests on the Moon based in Pleaux, Cantal, France; where he designs global citizen science pathways that bridge lunar geology, closed ecological systems, and STEM literacy. Nevin holds a Master of Science in Medical Sciences from the University of North Texas Health Science Center, alongside an academic background spanning biochemistry and philosophy from Baylor University. As the founder of Phronesis Consulting Services and creator of the "ARTEMIS Mindsets" framework, his work actively integrates human factors, extreme-environment simulations, and international collaboration to cultivate the next generation of space pioneers.

Abstract

As humanity transitions from temporary lunar exploration to permanent habitation, establishing sustainable In-Situ Resource Utilization (ISRU) and Bioregenerative Life Support Systems (BLSS) is critical. However, a significant operational gap remains in cultivating the global workforce required to design, manage, and maintain these complex biological and geological systems. To address this workforce pipeline deficit, the Spring Institute for Forests on the Moon has deployed a scalable, sequential educational pathway designed to build early-stage technical competencies, space-literacy, and global lunar collaboration.

The initial phase of this pipeline utilizes the CORRESPONDANT SCIENTIFIQUE workshop framework. Operating under the core premise that the Moon lacks true organic soil, this initiative positions K-12 students as active planetary geologists tasked with solving the challenge of soil genesis. Through rigorous citizen science protocols, participants conduct microscopic and geological characterizations of eight diverse soil and regolith simulant samples. Students catalog essential metrics including color profiles, granulometry (measuring grain sizes down to sub-millimeter scales), and grain morphology. By distinguishing between rounded grains (indicative of Earth-based weathering) and angular grains (indicative of lunar volcanic or impact activity), students decode geological histories. This hands-on analysis directly feeds into critical-thinking challenges aligned with advanced aerospace research. Students evaluate the bioregenerative potential of their

samples, brainstorming the exact amendments, microbial processes, and low-cost techniques needed to convert sharp, toxic regolith into a viable living medium for closed-loop hydroponics and life-support infrastructure. Furthermore, they engage with the "Technosignature" challenge, exploring how future geologists might identify human-altered "Anthropocene" soils containing microplastics. This technical foundation is balanced by the "Good Ancestor" framework, a philosophical layer challenging students to reflect on our ecological footprint and stewardship as humanity leaves permanent marks on the pristine lunar surface.

This foundational workshop serves as the direct onboarding step for the Institute's advanced, longitudinal citizen science project: TICTACS (Tool for Investigating Closed Terrariums Assisted by Citizen Science). Through TICTACS, students graduate to managing standardized, low-cost, citizen-assembled closed ecological systems. Equipped with automated sensor suites, these terrariums require zero maintenance and deliver continuous, real-time data regarding closed-loop ecosystem health and metabolic shifts in response to varying environmental stressors.

Led by the Institute's North American Outreach branch, this structured educational trajectory provides a concrete blueprint for aerospace workforce development. By decentralizing advanced STEM training, the Spring Institute democratizes space participation, fosters transcontinental student collaboration, and prepares the next generation of researchers, engineers, and visionaries to sustain permanent human communities on the Moon.

Beyond Analog Missions: A Frugal Framework for Developing ATLASS—A Persistent Virtual Living Testbed for Global Lunar Analog Research

Title: Beyond Analog Missions: A Frugal Framework for Developing ATLASS—A Persistent Virtual Living Testbed for Global Lunar Analog Research
Track: Other
Author: Dr. Claire A. Nelson
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E-mail: nelson.claire@gmail.com

Bio

Dr. Claire Nelson, Chief Visionary Officer of The Futures Forum, listed among Forbes Top 50 Female Futurists is Founding Convenor of the global community of practice, Space Futures Forum. The Curator of Space Ungana – an international conference for advancing space research and education in Africa, Founder of OASEAS (Open Afrika Experimental Space Exploration Analog Simulation), and Co-Founder of the Caribbean Space Society, serves as Advisor to various groups including, Institute of Space Law and Ethics/For All Moonkind, Space for Humanity, and SpaceKidz India.

Dr. Nelson, the author of the game-changing book "SMART Futures for a Flourishing World: A Paradigm Shift for Achieving Global Sustainability" is a sought-after speaker, with engagements including, ISU Space Exploratory Workshop, Saudi Space Debris Conference, Dubai Futures Forum, UNESCO Futures Festival, and the UN-OOSA Emerging Space Nations Workshop. A former member of the Board of the World Futures Studies Federation, she serves as Editor-At-Large of its flagship magazine Human Futures.
A social entrepreneur, Dr. Nelson is Founding President of the Institute of Caribbean Studies, Washington DC, and has been commended in the US Congressional Record for her leadership as the Convening Chair of the Campaign for June as National Caribbean American Heritage Month.
Her honors include being named a Global Goodwill Ambassador for UN International Moon Day by the Moon Village Association; recognition by ASCEND (Diverse Dozen) for her advocacy for a Space Futures Collaboratory for space sustainability; Outstanding Alumni, Purdue University Industrial Engineering Department, and a Finalist for Playmaker of the Year at the inaugural Global Space Awards, December 2026. The White House Champion of Change holds a Doctorate in Engineering Management from George Washington University.

Abstract

As international efforts toward sustained human presence on the Moon accelerate, participation in analog research remains concentrated within a small number of well-funded institutions, limiting opportunities for universities, engineering schools, and researchers in emerging space nations. This paper proposes ATLASS (Analog Testbed for Lunar Architecture, Systems and Sustainability) as a persistent virtual living testbed and

collaborative research infrastructure for the design, integration, and validation of digital twins supporting future lunar communities.

Rather than replacing physical analog habitats, ATLASS extends their scientific value by enabling multinational, transdisciplinary collaboration through interconnected digital twins, participatory simulation, and citizen science. Conceptualized using the SMART Futures Design Framework, the ATLASS Ecosystem would apply Sustainable Systems theory to model integrated habitat functions; Meaningful Metrics to monitor engineering and operational performance; Anticipatory Agency to engage students, researchers, and citizens as co-designers; Robust Resilience to iteratively test and improve system performance; and Transformational Technology to integrate digital twins, virtual analogs, and collaborative online research.

The framework adopts a frugal innovation approach, demonstrating how freely available software, open engineering practices, and distributed collaboration can progressively develop digital twins of critical habitat subsystems including energy, water recycling, air revitalization, food production, communications, governance, and human operations.

The paper proposes a phased pilot research program beginning with collaborative Design Dojos and multidisciplinary Hackathons, progressing through subsystem digital twin development, platform integration, towards the development of a persistent 48-hour virtual analog mission. Developed in support of the LUNARIAH vision for a citizen-owned lunar conservancy, ATLASS provides a scalable pathway for democratizing analog research, strengthening engineering education, fostering citizen science, and enabling globally distributed participation in designing sustainable human communities beyond Earth.

The Top Ten Challenges to the Economic Development of the Moon

Title: The Top Ten Challenges to the Economic Development of the Moon
Track: Other
Author: James Plaxco
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E-mail: jimplaxco@chicagospace.org

Bio

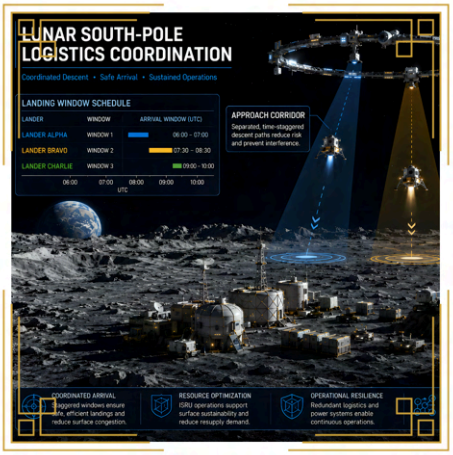
Jim Plaxco is President of Chicago Society for Space Studies, serves as the Economics SME for the NSS Space Ambassadors Program, and is a NASA JPL Solar System Ambassador. Currently serving on the NSS Board of Directors, Jim previously held the positions of NSS Vice President for Chapters and NSS Director of Information Systems. Jim's professional career was spent in corporate IS/IT. Jim is also a digital artist, creative coder, web consultant, and writer of haiku.

Abstract

"The Top Ten Challenges to the Economic Development of the Moon" provides an analysis of the key barriers to the successful development of the Moon from a business perspective. These barriers are categorized into three problem domains.
The first problem domain is that of the natural lunar environment which consists of Moon's lack of atmosphere, the day/night cycle, temperature extremes, the low lunar gravity, the radiation environment, and the nature of the lunar regolith.
The second problem domain is that of the technology regime, which can be evaluated based on both the Technology Readiness Levels (TRL) and Manufacturing Readiness Levels (MRL) of those technologies most directly associated with ISRU, from mining to refining.
The third problem domain is that of the business challenges. Components of this domain include transportation costs, forced vertical integration due to lack of infrastructure, ambiguous legal frameworks and property rights, lack of interoperability and systems standardization, insurance premiums and financial risks, and a complete lack of proven markets.
The three problem domains are interrelated in that the lunar environment and the technology regime combine to further impact the economic sustainability of all commercial operations undertaken on the Moon.
The ten individual challenges directly addressed are the radiation environment, the thermal environment in conjunction with the 14-day lunar night, the lunar dust hazard, ISRU technologies, transportation costs, forced vertical integration, unproven markets, a lack of

operational standards, insurance and financial risks, and the ambiguous legal frameworks which is compounded by a lack of defined property rights.

From Orbit to Outpost: Human-AI Coordination for Lunar South Pole Logistics



Title: From Orbit to Outpost: Human-AI Coordination for Lunar South Pole Logistics
Track: Alpha: Surface Infrastructure & ISRU
Author: Wanjiku Chebet Kanjumba
Affiliation: Vicillion
E-mail: wanjiku@vicillion.com

Bio

Wanjiku Chebet Kanjumba is an aerospace engineer, futurist, entrepreneur, and Ph.D. Candidate in Aerospace Engineering at the University of Florida, where her work focuses on space infrastructure, cislunar operations, in-space servicing, and interplanetary logistics. She is Co-Founder and CEO of Vicillion, an aerospace company advancing interoperable commercial-spaceflight and spaceport systems, and an R&D Career Astronaut Candidate with Titans Space. Her research spans hybrid human-AI coordination for the Earth-Moon corridor, autonomous lunar infrastructure, modular docking and capture systems, and integrated spaceport networks. Wanjiku has presented research at major international aerospace forums, including the International Astronautical Congress, COSPAR, and AIAA conferences. She is a member of the Forbes Africa's '30 Under 30' Class of 2026 and the first Kenyan-born graduate of the Advanced PoSSUM Academy Scientist-Astronaut Candidacy program. Her long-term mission is to help build the transportation and operational infrastructure required for sustained human activity on the Moon and beyond.

Abstract

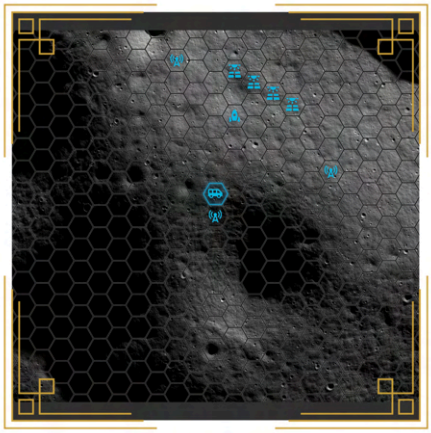
Permanent lunar settlement depends on multiple factors: habitats, power, and ISRU systems, as well as the reliable movement of crew, cargo, robots, and propellant from lunar orbit to surface sites. At the lunar south pole, multiple landers operating within limited illumination, communications, and terrain-access windows could create conflicts long before traffic becomes dense: overlapping descent profiles, radio-frequency interference, plume and dust exposure, navigation-sensor contention, and delayed responses caused by Earth-Moon communications latency.

This presentation proposes a settlement-focused coordination layer for the final orbital-to-surface segment of lunar logistics. Drawing from the Cislunar Zoning Protocol developed within broader Cislunar Orbital Traffic Control (CLOTC) research, the concept connects three operational regions: a low-lunar-orbit staging hub, coordinated polar approach corridors, and a surface operations area. Participating missions exchange standardized trajectory, timing, maneuverability, and communications data. A human-supervised AI scheduler then assigns arrival and descent windows, predicts conflicts, and recommends adjustments before vehicles enter high-consequence approach phases.

A representative scenario examines three commercial landers delivering cargo and ISRU equipment to the South Polar region within a 24-hour period. The system sequences approaches, separates high-interference activities, and preserves contingency windows without unnecessary delta-v. The talk will identify measurable design requirements, including window-allocation latency, schedule stability, communication conflicts, missed-approach capacity, and human decision workload, and outline a validation path using cislunar digital twins, software-in-the-loop testing, and analog mission rehearsals.

The result is a practical bridge between cislunar traffic coordination and surface infrastructure. Lunar developers can increase throughput and resilience while protecting science, ISRU, and habitation operations at the Moon's most strategically important sites by treating safe arrival, descent, and logistics cadence as shared infrastructure.

Moonbase 2026: Building a Lunar Colony Simulator with Healthcare-Grade Infrastructure



Title: Moonbase 2026: Building a Lunar Colony Simulator with Healthcare-Grade Infrastructure
Track: Alpha: Surface Infrastructure & ISRU
Author: Abigail Watson
Affiliation: Orbital Health Systems, Inc
E-mail: abigail@orbital.healthcare

Bio

Abigail ("Abbie") Watson is the founder of Orbital Health Systems, Inc., a Nevada C-Corporation developing portable electronic health record (EHR) systems for mobile, off-grid, and remote environments. The company adapts modern healthcare infrastructure for use in ambulances, mobile health clinics, RVs, commercial transportation, maritime operations, aviation, spacecraft, and future lunar habitats.

Watson holds a Master of Science in Biomedical Informatics from the University of Chicago and has worked at multiple federally funded research and development centers, including MITRE's Center for Advanced Aviation System Development (CAASD) and the CMS Alliance to Modernize Healthcare (Health FFRDC). This work has supported the FAA Office of Aerospace Medicine, the Centers for Medicare & Medicaid Services, and national healthcare interoperability initiatives.

Current research explores how modern clinical information systems and open interoperability standards can support long-duration human spaceflight, lunar infrastructure, and the emerging cislunar economy.

Abstract

Like many children of the Space Shuttle era, I grew up playing flight and city simulators. One of the classics was MoonBase: Lunar Colony Simulator, released during the same period that NASA's Space Exploration Initiative renewed serious discussion of permanent lunar settlements in the early 1990s. The engineering studies of the era imagined everything from small outposts to settlements of thousands of people, and those ideas naturally found their way into the video games many of us grew up with.

Naturally, my thoughts returned to that Moonbase simulator when Space Policy Directive-1 was announced, and I've spent the past decade wondering what it would look like if it were written today using modern clinical information systems. After all, critical care hospitals have spent decades solving problems that future space habitats will also face: limited resources, continuous monitoring, multidisciplinary coordination, logistics, emergency response, and long-duration human care. Why not build on those decades of engineering

instead of building bespoke systems from scratch? Why not leverage economies of scale that already exist when building the commercial space industry?

Since nobody else seemed to be asking these questions, I began prototyping ideas. And rather than building another simulator from scratch, I began asking different questions: What if we treated a space habitat like an inpatient medical home? What if the electronic health record became part of the life support system? Instead of thinking in terms of a rocket carrying a medical kit, what if we thought in terms of an air ambulance that just happened to be spaceworthy?

Built on modern open-source healthcare infrastructure — including HL7 FHIR and Node on FHIR — Moonbase 2026 has evolved into a simulator for crew health, life support, logistics, mission timelines, surface operations, and lunar habitats. Instead of treating healthcare as a separate application, it models oxygen, water, calorie consumption, and human physiology as foundational resources within an integrated lunar colony economy.

This session is a live demonstration of the Orion life-support simulator module, the lunar surface operations module, and a walkthrough of a hypothetical crewed Astrobotic Griffin mission on the Nobile Rim crater. Along the way, we'll explore how standards-based software, physiology simulators, and interoperable data models can support engineers, clinicians, researchers, and commercial organizations building the cislunar economy.

Moonbase 2026 is intended to be more than a demonstration — we’re building infrastructure for situational awareness, mission analysis, and contingency planning. While doing so, we see opportunities to partner with analog missions, develop new concepts of operations, field test new technologies, and participate in community challenges that compare mission designs, resource utilization strategies, and crew outcomes.

If we're serious about establishing permanent settlements beyond Earth, then we should begin by building—and sharing—the software that lets us rehearse them together. Sometimes the best way to imagine the future is to rebuild an old idea with the tools we've developed over the last thirty years.

Transplanting Jurisprudence, Not Law: Why Space Governance Requires a Foundational Rethinking of Legal Theory

Title: Transplanting Jurisprudence, Not Law: Why Space Governance Requires a Foundational Rethinking of Legal Theory
Track: Other
Author: Nadav Shaltiel
Affiliation: Nova school of law - The Space Law Research Centre (SPARC)
E-mail: nadav.shaaltiel@gmail.com

Bio

Nadav Shaltiel is a Ph.D. student at NOVA School of Law. His research focuses on how international law responds to disruptive technologies, particularly artificial intelligence, autonomous spacecraft, and quantum computing. Nadav holds a master's degree in political science, with a dissertation on the privatization of security forces in the United States. He has previously worked in the fields of international disarmament and emerging technology governance, representing ICAN and Stop Killer Robots in Israel, conducting comparative studies on NATO military structures, and participating in the Israeli Pugwash delegation.

Abstract

Space governance scholarship has produced a sophisticated body of regulatory proposals — treaty adaptations, constitutional frameworks for Martian settlements, and normative instruments such as the Artemis Accords — but this literature rests on a tacit and unexamined assumption: that the challenge of governing human communities in space is one of selecting and adapting appropriate legal rules, and that jurisprudential theory — the foundational conditions under which law claims authority and generates obligation — remains stable across the passage to space. This article challenges that assumption. Using five major jurisprudential traditions — Hart, Fuller, Luhmann, Dworkin, and Raz — the talk demonstrates that each presupposes ontological conditions that extraterrestrial environments structurally destroy: the approximate equality of agents, the functional differentiation of social subsystems, ecological sufficiency, and shared institutional history. The practical consequence is the structural impossibility of due process as terrestrially conceived. Because governance structures formed in early settlement phases tend to crystallise and persist, the argument advanced here is urgent: space governance requires not better legal transplants but a foundational jurisprudential discourse adequate to closed-loop, life-sustaining environments.


DAY 2
SATURDAY 18TH OF JULY

From Advocacy to Action: The Moon Society's Role in the NASA Moon Base Initiative

Title: From Advocacy to Action: The Moon Society's Role in the NASA Moon Base Initiative
Track: Other
Author: James Burk
Affiliation: The Moon Society
E-mail: jburk@moonsocietuy.org

Bio

James Burk is CTO of North Bend Digital, leading solutions architecture and engineering for several client companies. He is also the Executive Director of the Mars Society and a board member and past Vice President of the Moon Society. A professional analog astronaut, he served as Commander of Crew 261 at the Mars Desert Research Station.

Abstract

In March 2026, NASA announced its Moon Base initiative, a phased program to establish a sustained human presence near the lunar South Pole. The first robotic missions are already targeted for this year, and the agency has invited industry, academia, and other stakeholders to help shape the systems and research that will follow. For the Moon Society, this is a defining moment. After decades of advocating for the human settlement of the Moon, the organization now operates in a landscape where its mission aligns directly with national priorities and a rapidly expanding lunar economy.

This talk examines where the Moon Society can contribute and how it can do so without duplicating the work of agencies and commercial providers. The most immediate opportunity lies in lunar analog research. Terrestrial analog studies remain one of the most accessible and affordable ways to test habitat operations, surface mobility, crew protocols, and life support concepts before they reach the Moon. The Moon Society is well positioned to convene this work, drawing on its membership and by leveraging its community of lunar scientists and advocates.

The path forward runs through partnership. By collaborating with established research stations, university programs, professional societies, and emerging commercial teams, the Moon Society can help design and host new analog campaigns that generate useful data and genuine public engagement. These activities also support workforce development, giving students and early career professionals a direct route into the lunar enterprise.

This presentation will outline practical partnership models, identify research questions suited to analog environments, and propose an agenda for the months ahead. The goal is to position the Moon Society as a trusted contributor to the return to the Moon, and to

ensure that its members play an active role in building humanity's first home on another world.

Project Shackleton

Title: Project Shackleton
Author: Alan Meyer
Track: Alpha: Surface Infrastructure & ISRU
Affiliation: Rustic Anvil Forge LLC
E-mail: alanmeyer824@gmail.com

Bio

Alan Meyer, Senior Mechanical Designer, Mechanical Drafter, and Proprietor of Rustic Anvil Forge LLC. A dedicated advocate for sustainable, modular engineering, he currently serves as the lead designer for **Project Shackleton**, an initiative focused on lunar infrastructure, resource extraction, and logistical staging. By combining traditional craftsmanship with modern AI partnership, and advanced, SolidWorks modeling techniques—Alan bridges the gap between digital design and functional, real-world application.

Abstract

Project Shackleton is a blueprint for the future of lunar exploration, designed to turn the challenging environment of the Moon's South Pole into a sustainable base for human activity. By combining modular habitat architecture with rugged resource extraction systems and smart logistical staging, this project solves the most critical problems of lunar survival—namely, how to build structures that last and how to harvest local materials for power and water. It is a pragmatic, "boots-on-the-ground" engineering approach that bridges the gap between high-tech aerospace requirements and the realities of harsh-environment manufacturing. Designed for durability and scalability, Project Shackleton aims to transform a remote, icy crater into a functioning, long-term outpost for humanity.

Terran technology refers to the collective body of engineering, manufacturing, and technical expertise developed and utilized by humans on Earth. It encompasses everything from traditional artisanal craftsmanship and industrial machinery to the advanced aerospace solutions required to establish sustainable infrastructure in extraterrestrial environments.

Validation Statement

Validation of these modular infrastructure concepts is achieved through advanced 3D CAD parametric modeling to verify geometric tolerances, spatial staging layouts, and structural clearance. Furthermore, the development of a localized workflow utilizing monochromatic heightmaps and topographic data serves as the baseline mathematical model to validate

regolith processing and autonomous sub-grade rover routing.

Engineering humanity's foothold through pragmatic innovation.

The Invisible Infrastructure: Why AI May Become the Operating System of Lunar Civilization

Title: The Invisible Infrastructure: Why AI May Become the Operating System of Lunar Civilization

Track: Track Alpha: Surface Infrastructure & ISRU

Author: Lars R. "Jones" Vadjina, Affiliation: FUTURE DREAMS GmbH,
Email: vadjina@future-dreams.com

Bio

Lars R. “Jones” Vadjina is a Certified Innovation Manager, futurist, and interdisciplinary researcher focused on artificial intelligence, space settlement, governance, and long-range futures. He has presented at international conferences, including SpaceCom, the Lunar Development Conference, ReInventing Space, AIAA SciTech, and AIAA ASCEND. His work examines how intelligent systems, institutional design, and emerging technologies can support resilient human societies in extreme environments on Earth, the Moon, and beyond.

Abstract

When people imagine the first permanent lunar settlements, they typically picture rockets, habitats, solar arrays, life-support systems, and regolith-processing plants. However, history suggests that infrastructure alone does not create civilizations. Roads do not govern themselves. Power grids do not allocate resources. Settlements do not coordinate thousands of interconnected decisions without systems capable of managing complexity. As humanity moves from short-duration missions toward permanent lunar presence, a less visible form of infrastructure may become just as important as physical hardware: artificial intelligence.

Future lunar settlements will operate in environments characterized by extreme constraints, communication delays, limited personnel, resource scarcity, and tightly coupled technical systems. Energy production, life support, logistics, maintenance, mobility, scientific operations, and emergency response must function as an integrated whole. As settlements grow in size and complexity, human operators alone may struggle to coordinate the volume of information and decisions required for efficient and resilient operation.

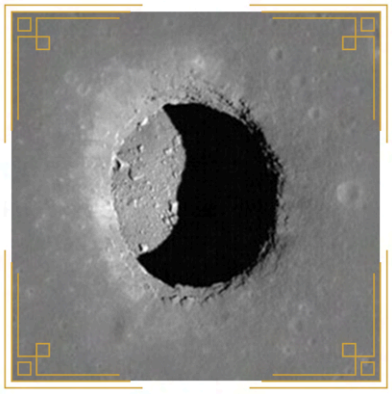
This presentation explores the possibility that AI may evolve from a specialized tool into a foundational layer of lunar civilization itself. Rather than focusing solely on autonomous robots or individual applications, it examines AI as a settlement-wide coordination system that supports resource management, predictive maintenance, governance processes, knowledge preservation, and long-term resilience.

Drawing upon current developments in artificial intelligence, complex systems theory, and lunar settlement planning, the presentation argues that AI may become the invisible infrastructure that enables sustainable human presence beyond Earth. The central question

is not whether future lunar settlements will use AI, but whether permanent lunar civilization can emerge without it.

As we design habitats, power systems, and transportation networks for the Moon, we may also need to design the digital institutions that allow those systems to function together. The future of lunar development may depend not only on the infrastructure we can see, but on the intelligence operating quietly beneath it.

San Xavier Decline as an Analog Lava Tube for Testing Autonomous Lunar Mining Systems and Infrastructure



San Xavier Decline, Mare Tranquilitatis pit by NASA, Art by Microsoft Copilot

Title: San Xavier Decline as an Analog Lava Tube for Testing Autonomous Lunar Mining Systems and Infrastructure

Affiliation: School of Mining Engineering and Mineral Resources - University of Arizona
Author: Ethan Williams and Victor Tenorio
E-mail: ewilliams3@arizona.edu, vtenorio@arizona.edu

Bio

Ethan Williams is an undergraduate student at the School of Mining Engineering and Mineral Resources, University of Arizona. His academic focus includes mine production and equipment efficiency, with a growing interest in lunar mining. He presented at the Space Institute Symposium in 2025 and 2026 and was exhibitor of Moon Mining themes for Mines for Limitless Minds (2024 and 2025), both at the University of Arizona campus. He is also a member of the Wildcat Moon Miners team, participating actively in the 2024-2025 RASC-AL competitions.

Bio

Victor Tenorio is a Professor of Practice at the School of Mining Engineering and Mineral Resources, University of Arizona. His research interest is focused on Smart Mining and Decision Support Systems for optimizing productivity. Worked on several engineering projects in Peru, Chile, and the United States. Founder of Wildcat Moon Miners (2021), a research team dedicated to participating in Space Mining-related projects and competitions.

Abstract

The development of lunar mining systems requires validation in environments that approximate subsurface conditions expected in lunar lava tubes. This work proposes the use of the San Xavier Mining Laboratory decline as a terrestrial analog for testing autonomous and semi-autonomous mining technologies under confined, non-GPS conditions. The study integrates robotic excavation platforms, swarm systems, and multi-sensor payloads (e.g., LIDAR, optical sensing, and communication networks) to evaluate navigation, material handling, and support operations within an underground setting. Field simulations include human and robotic traversal of the decline to replicate operational workflows in lunar lava tubes, focusing on communications, localization, and system interoperability. Observations are used to develop a comparative framework linking terrestrial

results to expected lunar conditions, accounting for differences in gravity, regolith properties, and environmental constraints. The outcomes contribute to technology readiness, risk reduction, and the design of adaptive systems for future in-situ resource utilization missions.

Diversification of Lunar Surface Space Suits

Title: Diversification of Lunar Surface Space Suits

Author: Cameron Smith
Affiliation: Portland State University
E-mail: b5cs@pdx.edu :

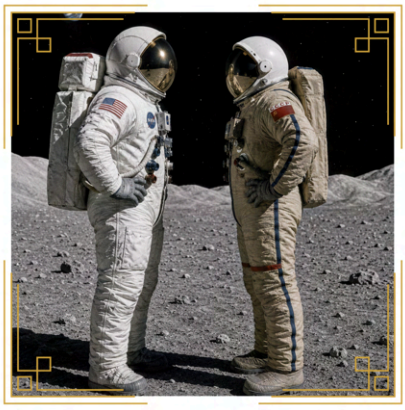
Bio

Dr. Smith of Portland State University applies what we know of human evolution, cultural and biological, to develop adaptive strategies for multigenerational success in space settlement. He is also involved in the testing and development of material adaptations to space environments, including space suits, as co-Director of the Center for Human Space Exploration at the University of Arizona's Biosphere2.

Abstract

Project _Apollo_ demonstrated that effective lunar surface space suits could be relied on for several days of exploration. Future lunar plans include many non-exploration activities that will require a variety of space suit designs and functions. I review a variety of such prospective garments, including suits for active construction, construction management, subsurface and surface activities, spacecraft and habitat maintenance, and others.

Good Fences Make Good Neighbors



Title: Good Fences Make Good Neighbors
Track: Track Alpha: Surface Infrastructure & ISRU
Author: Nicolas Nelson
Affiliation: Luna City Press
E-mail: parepidemos1@gmail.com

Bio

Senior Editor of Luna City Press, worked with James Burk and other editors to prepare Peter Kokh's books for publication. Founder and head coach of Wordsmith Writing Coaches, former VP of the Greater Los Angeles Writers' Society, mentor and instructor for the ISM Writers Collective, mentor and instructor for BYEB (Build Your Editing Business), leader of PRESS "the writers' group that gets work done!" and popular speaker at writers' conferences and symposia across the West Coast. Space enthusiast for the past 45 years!

Abstract

If the US had established a permanently-staffed lunar base sometime between 1990 and 2015, it would have followed the ISS management model, and there would not be a rush of other nations to establish their own bases as well. A US-led ISS-like international coalition would have already established the operational policies for future lunar exploration and development.

But now that we live in a multi-polar geopolitical reality, and have only now committed to a permanent human presence on the Moon, the Artemis program partners and the ILRS partners will be exploring and characterizing the same high-value sites on the Moon, and establishing lunar infrastructure —and eventually human habitats— within arm's reach of one another.

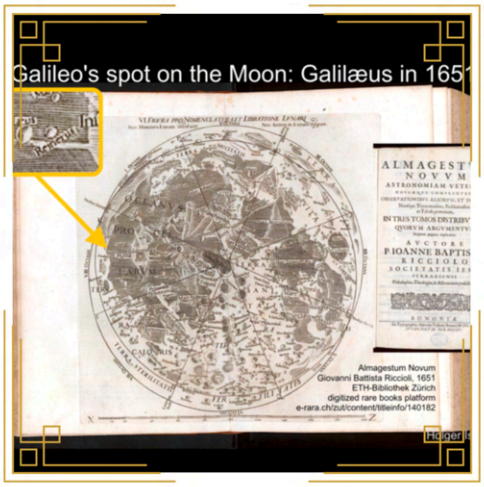
To ameliorate territorial and operational conflict on the Moon (especially in and around Shackleton Crater and other promising sites at the lunar south pole), we need to prepare. Ideally, we would want established international law to govern lunar operations, but those laws will follow, not precede, the situations in which they are needed (cf the first paragraph here).

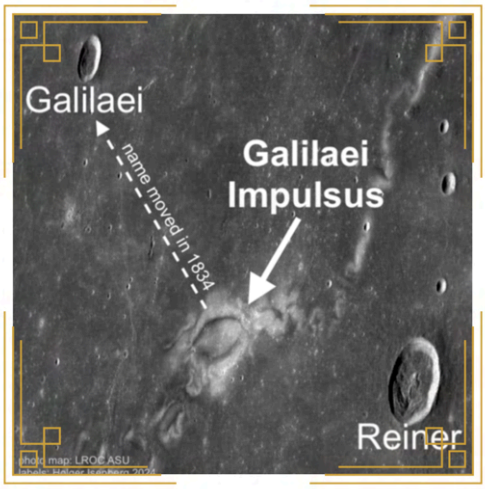
In lieu of established law, we need a compelling, well-articulated understanding of the principles and precedents to which we can appeal when conflicts arise. In this presentation we will review some of those legal and operational principles, and some analogous precedents, with which we can weave some helpful "fence material" to clearly define

critical operational (and ultimately political) boundaries that allow both competing teams to live and work safely and productively in close proximity on the Moon.

Because good fences make good neighbors, and for all those who will live and work on the Moon, their lives will depend on being & having good neighbors.
(And the *best* fences have clearly-defined and easily-operated gates that permit access when the situation justifies it— like offering rescue or seeking refuge!)

Returning Galileo to his original location on the Moon





Title: Returning Galileo to his original location on the Moon
Track: Other
Author: Holger Isenberg
Affiliation: Areo Info LLC
E-mail: isenberg@areo.info

Bio

Holger Isenberg has a master's degree equivalent in Computer Science from the Technical University Dortmund, Germany and has worked in systems operation and consultation around Java-based enterprise applications since 1999 in Germany and moved in 2016 to Silicon Valley, now solving customer problems at a company specialized on providing high performance Java platforms. As an independent researcher he is applying software engineering skills on public data provided by spaceflight missions for his Mars images website https://areo.info and the areoHDR app.

Abstract

The largest lunar surface swirl, located at the western equatorial limb of the Moon, originally named after Galileo Galilei in 1651 and later renamed Reiner γ (gamma) in 1935, is known to be a site of a significant magnetic anomaly. As shown in the presentation, this magnetic anomaly at the surface features reduced ionizing radiation, offering a natural shield to protect human explorers on the Moon. It could become a crucial aspect of human Moon exploration soon, which is also why the robotic IM-3 mission is planned to land at this location in late 2026. With that, it's time to honor Galileo once again by returning this important location to its original name.

The Living Wall: Pioneer Organisms as Biological Infrastructure in Lunar Lava Tube Habitats

Title: The Living Wall: Pioneer Organisms as Biological Infrastructure in Lunar Lava Tube Habitats
Track: Track Beta: Subsurface Settlement
Author: Silvia Schmalzl
Affiliation: Dr. Schmalzl Consulting
E-mail: schmalzl@dr-schmalzl.com

Bio

Dr. Silvia Schmalzl is a physicist, systemic consultant, and independent researcher exploring the role of pioneer organisms in future space habitation. With a Ph.D. in Physics from the University of Tübingen and over two decades in high-tech markets, she brings scientific grounding and systems-level thinking to questions at the edge of current space endeavors.
Her work on moss, lichens, and biological soil crusts examines how extremophile organisms (already proven in simulated space and Mars-like conditions) could function as active biological infrastructure in the environments lunar settlers will actually inhabit.
Dr. Schmalzl has presented at SpaceCom 2026, the International Space Development Conference (ISDC), and the British Interplanetary Society. Her current research focus bridges astrobiology, habitat design, and the biological conditions required for genuinely sustainable lunar presence.

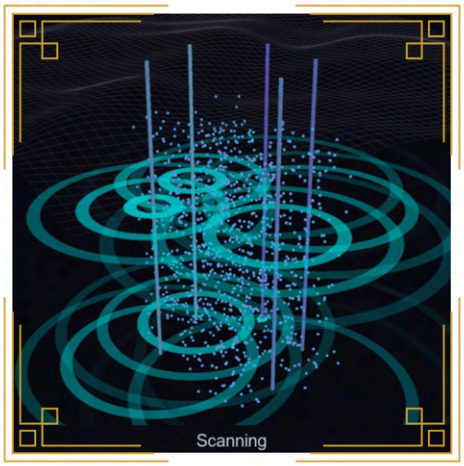
Abstract

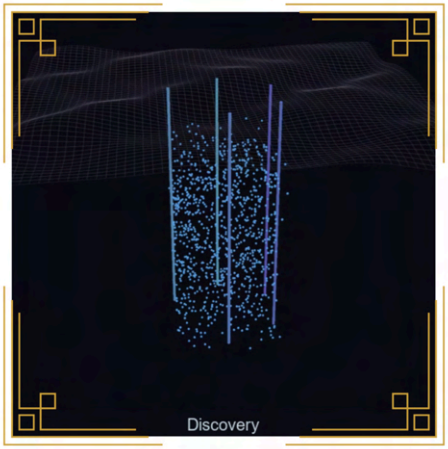
Lunar lava tubes offer a compelling architecture for long-term human habitation: natural radiation shielding, thermal stability, and structural protection from meteorite impact. Yet the current design conversation focuses almost exclusively on engineering: pressurization, structural integrity, and mechanical systems. A critical layer is missing: biology.
Mosses and lichens are among Earth's most radiation- and desiccation-tolerant organisms. Recent research demonstrates that select species survive simulated Mars-like conditions, including ionizing radiation, while remaining metabolically active. On Earth, biological soil crusts, dominated by mosses, lichens, and cyanobacteria, colonize bare rock and regolith, stabilizing surfaces, fixing carbon and nitrogen, and building the foundation for more complex ecosystems. They are, by definition, pioneers.
This presentation proposes that lunar lava tubes represent a scientifically plausible first environment for deploying pioneer organisms beyond enclosed life support systems, not on the open lunar surface, and not as terraforming, but as a living biological layer within a partially conditioned subsurface habitat. With humidity provided by an adjacent habitat module, mosses and lichens could establish on regolith walls and floors, creating a functional biological crust that provides a secondary attenuation layer against residual high-energy radiation, begins organic substrate conditioning, and introduces a self-sustaining biological presence at the boundary between raw rock and human space.

This is not science fiction. It is the next logical step from current extremophile research, applied specifically to the lava tube environment that lunar architects are already designing around.

The talk will examine the biological evidence base, the physical conditions required, and what this means for how we design the transition zone between the lunar rock and the human interior, arguing that the first settlers in a lunar lava tube may not be human alone.

Tetherless Drilling Robots (Borebots) for Polar Lunar Prospecting





Title: Tetherless Drilling Robots (Borebots) for Polar Lunar Prospecting
Track: Track Alpha: Surface Infrastructure & ISRU
Author: Quinn Morley
Affiliation: Unleashed Robotics
E-mail: quinn@unleashedrobotics.com

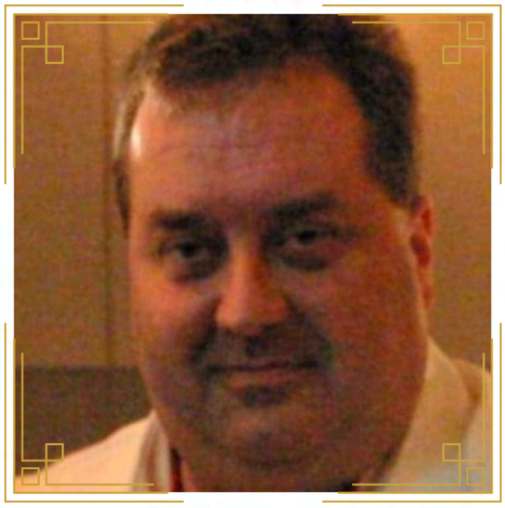
Bio

Quinn Morley left his mid-career fabrication job at Boeing in 2020 to make a risky bet on the space industry, and it paid off. While finishing his Mechanical Engineering degree at Washington State University, he was selected for a NASA Innovative Advanced Concepts Fellowship in 2021, and again in 2023. In 2025 he co-founded Unleashed Robotics to commercialize "Borebots" drilling technology for critical mineral prospecting on Earth and water ice prospecting on the Moon.

Abstract

Unleashed Robotics is commercializing a NASA-funded Mars drilling technology for subsurface resource prospecting on Earth and beyond. Our patent-pending FractalMining™ approach uses swarms of autonomous drilling robots to conduct subsurface radar surveys in the most remote regions of the planet, like a telescope into the underground.
Our Borebots™ drilling technology began with a NASA Innovative Advanced Concepts (NIAC) award, a grant from one of the highest-risk and most forward-looking programs in the federal R&D pipeline. That study was to investigate deep drilling into the Martian polar layered deposits (PLDs). Since that time, the concept has matured from a single Mars study into a space-resources platform spanning three worlds: critical-minerals prospecting on Earth, water-ice prospecting on the Moon, and in-situ resource utilization of water-ice for colony-scale subsistence and fuel production, enabling continued interplanetary transit. Our technology will also enable groundbreaking astrobiological and planetary protection investigations.

Beyond Earth: Toward a Pattern Language for Lunar Settlements



Title: Beyond Earth: Toward a Pattern Language for Lunar Settlements
Track: Other
Author: Hal Fulton
Affiliation: Open Space Foundation
E-mail: rubyhacker@gmail.com

Bio

Hal Fulton has two degrees in computer science and 40 years' experience in that field (including several years of teaching experience). He is the author of _The Ruby Way_, which was the second English-language book on the Ruby programming language.

As a life-long follower of spaceflight activities, he has been a member of various space advocacy organizations since joining the L5 Society (forerunner to the NSS) at age 14. He has been a volunteer or board member for some of the smaller groups.

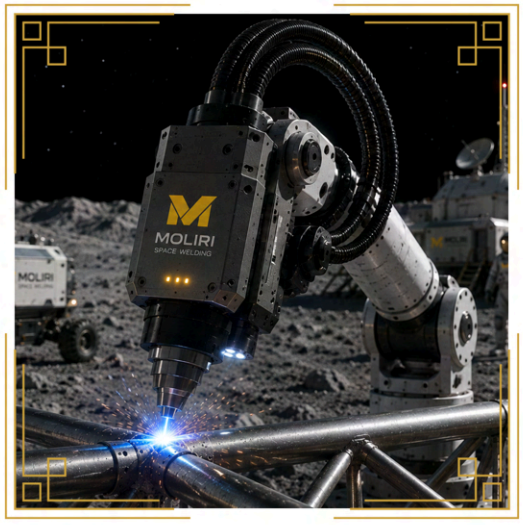
He believes that activity in the space arena, both human and robotic, is a fundamentally humanitarian endeavor that will benefit all humanity in the long term. That being the case, his intention is to devote a significant portion of his remaining life to advocacy and activism in the area of human space exploration and settlement, through books, educational materials, art, and any other practical means.

Abstract

Christopher Alexander's A Pattern Language captured hundreds of recurring design solutions that make human environments more functional, livable, and enduring. While developed for Earth, its underlying approach may be even more valuable as humanity begins designing permanent settlements beyond our home planet.
This talk explores what a "Lunar Pattern Language" might look like. Which of Alexander's patterns remain valid in one-sixth gravity? Which must be adapted for vacuum, radiation, abrasive dust, and extreme isolation? What entirely new patterns emerge when every kilogram is precious and every habitat is a life-support system?
Rather than presenting a finished catalog, the talk proposes a framework for identifying and documenting recurring solutions to recurring problems in lunar settlement design. Candidate patterns span architecture, operations, psychology, community design, and infrastructure—from dust transition zones and radiation refuges to social gathering spaces and visual connections with Earth.
The goal is not to prescribe specific engineering solutions, but to encourage a shared vocabulary for discussing human-centered design beyond Earth. Such a pattern language could help researchers, architects, engineers, and future settlers build upon one another's

experience as lunar communities evolve.

Moliri's Case for In-Situ Construction and Repair Capability in the Lunar Economy



Title: Moliri's Case for In-Situ Construction and Repair Capability in the Lunar Economy
Track: Track Alpha: Surface Infrastructure & ISRU
Author: Francesca Mison
Affiliation: Moliri Space Energy
E-mail: francesca@moliri.eu

Bio

Francesca Mison is a Space Systems Engineer at Moliri, a young Estonian startup developing in-space assembly technologies. With a background in Mechanical Engineering from Arcada University of Applied Sciences, she is currently authoring a phased capability framework, mapping the fabrication, joining, cutting, and repair tooling required for lunar infrastructure.

Abstract

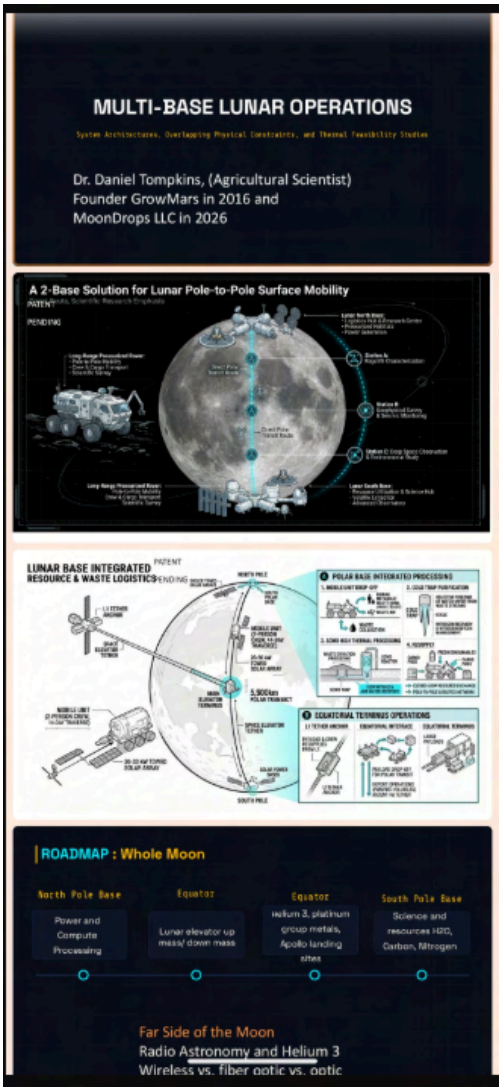
Establishing a permanent Moon base needs the ability to build, maintain, and repair infrastructure in situ. However, the robotic tools and processes do not exist. Furthermore, the lunar environment, defined by vacuum, thermal cycling, micrometeorite showers, and abrasive regolith, creates major challenges for conventional construction and repair methods.

Moliri is a young Estonian space startup developing in-space assembly technologies. The company's near-term focus is on robotic end-effector tools such as space laser welding tool for joining, repair and cutting and; rotary tool for screwing, drilling and milling. The next step would be building robots to use those tools to perform the servicing and construction activities. In the case of lunar, it could be a rover, walking robot and railway-inspired locomotion. The long-term vision of Moliri is construction of large space structures, for example large antennas and towers on the Moon.

This paper presents Moliri's roadmap towards the lunar economy through a phased framework of the tools and use cases required for lunar construction. Three process families: joining (including welding), cutting, and repair, are mapped across five target systems: rovers, communication towers, habitat modules, ISRU resource extraction plants, and launch infrastructure. Phase 1 prioritizes joining and cutting for use cases such as rover mobility and structural assembly. Phase 2 extends the framework to habitat construction, addressing use cases such as pipe installation, hull cutting, and radiation shielding. Phase 3 focuses on heavy structural work, including plant maintenance, fluid line installation, and launch pad fabrication. This roadmap is developed in direct alignment with NASA's phased Ignition Program roadmap to ensure the right tool exists at the right technical readiness level.

This work shows that in-situ welding, cutting, and repair are key requirements for sustained lunar development. Moliri's positioning as a supplier, with partnership pathways to space agencies, commercial lunar payload service providers, and habitat and infrastructure contractors, as well as ISRU technology developers, provides a route to deliver as lunar infrastructure grows.

MoonDrops, A Whole Moon Approach



Title: MoonDrops, A whole Moon Approach
Track: Other
Author: Daniel Tompkins
Affiliation: MoonDrops
E-mail: tompkinsdv@gmail.com

Bio

Agricultural scientist and Founder of GrowMars in 2016 and MoonDrops in 2026.

With extensive experience in environment and biosystems development, focusing and supporting and unlocking biology, materials, and humans in the loop to the fullest potential.

Abstract

MoonDrops founded in 2026 aims to unlock the resources of the Moon by dropping off and picking up resources at a Lunar North and South Pole base of operations.

Argonaut: Advancing Sustainable Lunar Exploration

Caption: To the right “Image credit: ESA”

Title: Argonaut: Advancing Sustainable Lunar Exploration
Author: Nona Zakoyan
Co-Author: Piercarlo Galeazzo
Track: Track Alpha: Surface Infrastructure & ISRU
Affiliation: Thales Alenia Space
E-mail: nona.zakoyan@thalesaleniaspace.com
E-mail: Piercarlo.Galeazzo@thalesaleniaspace.com

Bio

Nona Zakoyan is a Space System Architect and Engineer at Thales Alenia Space, contributing to Human and Robotics Planetary Exploration Programs based at the Turin site in Italy. She currently leads the System Physical Architecture of the ESA Lunar Lander Programme, Argonaut.
Previously, she worked on the Gateway Lunar I-Hab Programme aligned with her PhD research at UCL, focusing on module Physical Architecture, Layout, Habitability Design, and Human Factors using a User-Centered Design approach. She applied Extended Reality (XR), Virtual Reality (VR), and Human-in-the-Loop (HITL) testing with ESA and NASA astronauts to enhance user experience and habitability.
As a researcher, she contributed to R&D projects on commercial modules, lunar rovers, and crew quarters, and is an XR initiatives associate and Innovation Fellow at Thales Alenia Space.
Nona represented the company at major international events, such as at the Paris Air Show (2023, 2025) and IAC 2024 Milan, and presented three technical papers at the 35th IAA Symposium on Space and Society's session.
Piercarlo Galeazzo has been the ARGONAUT (EL3) Project Design Authority since 2020 and has worked at Thales Alenia Space since 1990. Serving as PDA/SEM since 2010, he has extensive managerial experience including Verification, AIT Manager, and Project/Payload Manager roles. His expertise spans the full lifecycle of space programs—from Proposal and Study phases through Implementation, Launch, and Mission activities. He has worked on diverse missions such as scientific satellites (e.g., TETHERED, SOHO), ISS payloads (e.g., SAGE/HEXAPOD, SOLAR/CPD, GEROS), optical payloads (e.g., EXOMARS Rover Payload), and lander systems (e.g., Heracles Lunar Ascent Element, EL3). Piercarlo has collaborated with space agencies (ASI, ESA, NASA) and major industry partners including AIRBUS, ORBITAL, TAS, LEONARDO, and BALL Aerospace. He is an IPMA-certified Project Manager and recipient of NASA Group Achievement Awards (2017, 1994).

Abstract

The renewed international drive toward sustained lunar exploration is accelerating the development of advanced surface infrastructure capable of supporting long-term scientific,

technological and human activities on the Moon. Within NASA's Artemis programme and its international partnerships, lunar logistics systems constitute a critical enabling capability for delivering scientific payloads, technology demonstrators, infrastructure elements and resources required for future crewed exploration. Building upon the heritage of previous lunar missions, next-generation landers must combine precision landing, operational autonomy, flexibility and long-duration surface operations to support increasingly ambitious exploration objectives.

In this context, the European Space Agency's (ESA) Argonaut programme represents Europe's autonomous, versatile and reliable access to the lunar surface. Developed under the leadership of Thales Alenia Space as prime contractor for the Lunar Descent Element (LDE), Argonaut is a modular and aimed at a recurring production lunar logistics system designed to deliver up to 1,500 kg of cargo to a wide range of lunar destinations. The lander integrates advanced propulsion, autonomous navigation, precision Guidance, Navigation and Control (GNC), hazard-aware landing technologies and adaptable payload interfaces to enable safe and accurate autonomous landings. Landing accuracy is expected to improve from approximately 250 m on the first mission to 50 m by the third mission.
Designed for recurring missions beginning in 2030, with an operational lifetime of up to five years on the lunar surface, Argonaut provides a flexible logistics platform capable of transporting scientific instruments, robotic assets, technology demonstrations, astronaut consumables, communication systems, power infrastructure and in-situ resource utilization (ISRU) technologies. Its modular architecture supports evolving exploration needs while enabling the deployment of key elements of future lunar infrastructure.
This abstract and further conference discussion present an overview of the Argonaut programme, its system architecture and the key technologies enabling autonomous lunar cargo delivery. It discusses Argonaut's role in supporting sustainable lunar exploration, interoperability with international initiatives including Artemis, and Europe's strategic contribution to establishing a resilient and enduring lunar infrastructure through autonomous logistics capabilities.

Asteroid Impact Protection - Long Term Solution

Title: Asteroid Impact Protection - Long Term Solution
Track: Alpha: Surface Infrastructure & ISRU
Author: Michael Helton
Affiliation: Helton Associates
E-mail: mr.helton@verizon.net

Bio

Mike Helton is a retired Aerospace Engineer. He has a BS in Aeronautical Engineering from Purdue (1966) and a Masters in Astrodynamics from UCLA (1972). At North American Rockwell he worked on many proposals for interplanetary missions, the Apollo Program and the Space Shuttle proposal. At JPL he worked on the Mars mapping mission (Mariner Mars '71), as a trajectory engineer for the Pioneer 10 & 11 missions, as a systems engineer on the Galileo mission, and 3 temporary assignments to NASA Headquarters. He worked as an integration manager on the early design of the Space Station, and worked as a Risk Manager for many government programs (20 years) and taught a class on how to be a Risk Manager to over 350 professionals.

Mike Helton is the sole proprietor of his own investment company – Helton Associates. This company consults and fosters interchange with leading edge science and 'high tech' companies.

Abstract

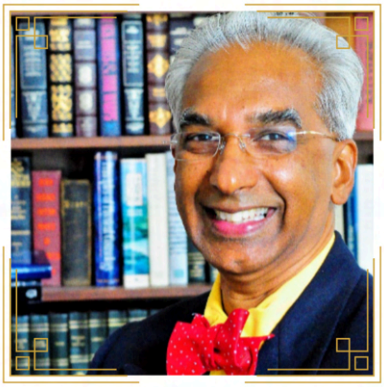
The Lunar surface is peppered with craters from meteoroid and asteroid impacts over time. Current estimates of asteroids greater than 140 m in diameter that orbit around the Sun near cis-lunar space are 25,000.

The asteroid impact problem is long term since we know most large asteroids are a danger to the cis-lunar space. Therefore, a long-term solution is appropriate to consider. This paper presents an asteroid orbit control strategy that results in complete protection that is sustainable in time and near zero cost. The confluence of advancing AI with advancing robotics together with technologies developed for Lunar surface occupation and Mars settlements can produce the solution presented in this paper.

This solution uses advanced robotics with evolved AI and advanced technologies in using 3D machines and ISRU to make thrusters and fuel with required structure assemblies to provide a thrust operation and strategy to make small continuous adjustments to the asteroid orbit. This would result in a slow migration of the asteroid out of the Earth – Moon – Mars vicinity and into the Asteroid Belt.
The AI Robots would be able to duplicate themselves, make transfer rockets and navigate to other asteroids. In time, thousands of asteroid orbits will be migrating out to the Asteroid

Belt. In so doing, we would 'clean up' the inner Solar System and allow a safer existence in the Earth - Moon - Mars domain.

Commercial CisLunar Orbital Amateur Astronaut Space Tourism



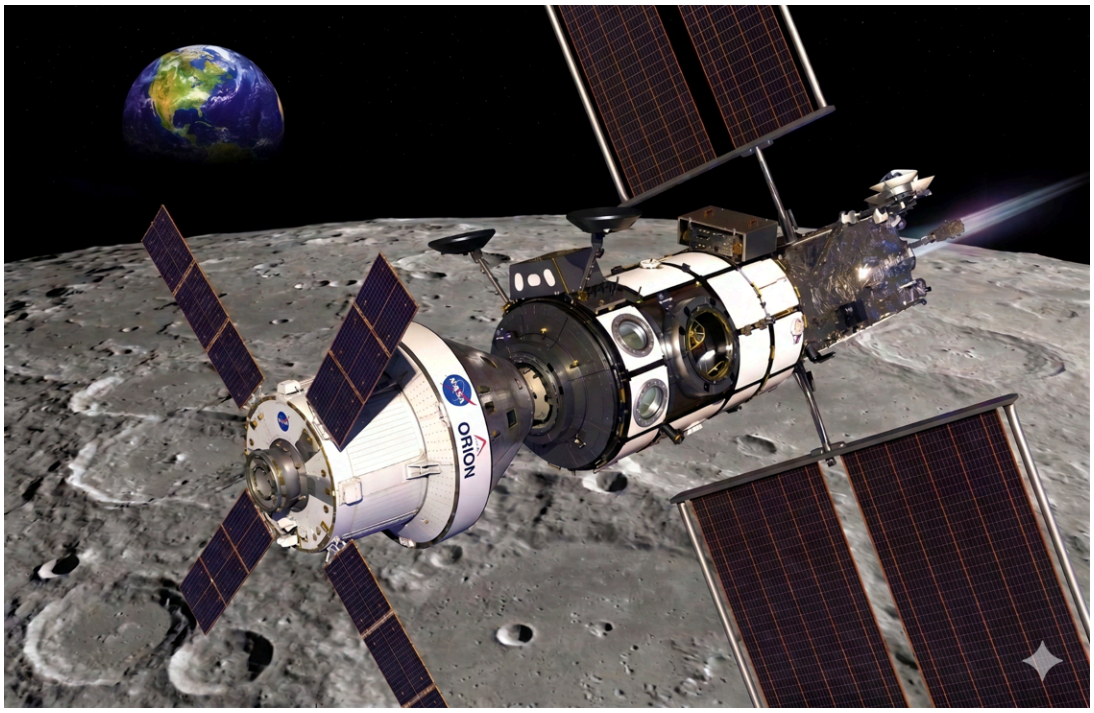


Figure 1. A retrofitted Gateway module would be part of existing assets, along with the PPE elements that would form the backbone of a cislunar cycling spacecraft architecture, heralding the arrival of Cislunar Orbital Space Tourism(COAST) where scientific exploration and technology development ride on the back of truly self-sustainable commercial human deep space activities.

Title: Commercial CisLunar Orbital Amateur Astronaut Space Tourism
Track:
Author: Madhu Thangavelu
Affiliation: Astronautical Engineering Department, Viterbi School of Engineering & School of Architecture. Faculty, International Space University. Board of Directors, National Space Society. North American Coordinator, Moon Village Association
Links: https://today.usc.edu/profile/madhu-thangavelu/
https://pressroom.usc.edu/madhu-thangavelu/
https://arch.usc.edu/people/madhu-thangavelu
E-mail: mthangav@usc.edu

Bio

Madhu Thangavelu conducts the ASTE 527 graduate Space Exploration Architectures Concept Synthesis Studio in the Department of Astronautical Engineering within the Viterbi School of Engineering at the University of Southern California. He also teaches the Arch599 Extreme Environment Habitation Design Seminar in the School of Architecture, where he is a graduate thesis adviser. Madhu is a co-author of the book "The Moon: Resources, Future Development and Colonization", John Wiley &Sons 1999, and the second Springer/Praxis edition was published in 2007, third edition in preparation. He is a former Vice Chairman for Education, Los Angeles Section of the American Institute Of Aeronautics and Astronautics(AIAA). He has directed Space Exploration Projects at the California Institute of Earth Art and Architecture. Mr. Thangavelu is also the invited author of the chapter “Living On the Moon” in the Encyclopedia of Aerospace Engineering, a major reference work published by John Wiley and Sons in October 2010, updated in 2012. He was on the team that won the coveted NASA NIAC Phase 1 and 2 awards consecutively for developing robotic building technologies on the Moon and Mars. Mr. Thangavelu’s concept creation work was greatly appreciated for proposing ideas that pointed to the “leading-edge sensor concept” for return to flight of the space shuttle fleet. Mr.Thangavelu is on the faculty of the International Space University, an international organization that offers advanced interdisciplinary, intercultural and international training for promising leaders and space professionals.
He is the North American coordinator for the International Moon Village Association based in Vienna, Austria. Madhu is on the Board of Directors of the National Space Society(NSS) and also the NSS Vice President and Liaison for NSS India region. He is also on the Board of Directors of the Alliance for the Collaboration in the Exploration of Space-ACES Worldwide. Madhu is also a creative consultant for the Space and entertainment industry.

Abstract

The International Space Station is set for decommission at the end of this decade. The current US policy has a mandate to include Space Tourism In the facility manifest before retirement. The Artemis II mission has proven the capability of the SLS and Orion spacecraft to safely carry crew and return them safely back to Earth.
Technology challenges for returning crew to the lunar surface include:
Lack of lunar lander EVA surface suit in development Lack of lunar surface transport and habitat infrastructure All these elements are in their development or certification phases and current plans are being revamped using engineering best practice to expedite the certification and commission of systems deemed critical for successful mission execution. No clear commission timeframe can be assigned for such elements as all of these elements require advanced technology acceleration and development schedule slips are inevitable. Several precursory CLPS missions are set to manifest in the 2026=2027 timeframe to verify the characteristics of the older and more rugged highland terrain of the lunar south polar region that is currently the target for lunar return.
Given the challenges facing the mission design for sustained operations in some of the harshest environments in our solar system that the lunar south polar region presents, engineering best practice dictates a phased approach to accessing the resources of the polar region that include volatiles, that can, if prospecting methods and beneficiation processes prove viable and sustainable, lead to a sustainable lunar settlement.

Needless to mention, the physics and engineering thermodynamics of operating systems, especially human systems like ECLSS, surface EVA suits, rovers and robotic assistants in the extreme lunar polar region environment is daunting and will require empirical data to support robust system evolution.
If permanent settlement of our Moon is the ultimate goal, a phased approach to critical system development is essential before robust systems can be fielded on site.
A phased approach for establishing a permanent cislunar settlement at a minimum should include evolving a sturdy transportation system and logistics channel and reliable round-the-clock communication network with ample redundancies to support a variety of activities including emergency and rescue operations.
The USC Astro Engineering studio has been advocating and studying how to manifest human missions speedily using a phased manner of deployment using existing assets while paying attention to true sustainability through profit motive that is practiced in healthy commerce industry, sans annual taxpayer fund handouts as practiced by governmental agencies.
Profit = Revenue – Cost is what drives self-sustaining endeavors. The current public-private partnership(PPP) paradigm offers hope for sustainable Space activities.

Under the prevailing condition, using the existing SLS+Orion complement in concert with ISS and the White House mandate to include Space Tourism in the ISS operations agenda, the COAST proposal, presented at this LDC 2026 offers a pilot project to examine the feasibility and eventual self-sustainability of cislunar orbital tourism, setting the stage for permanent lunar development.